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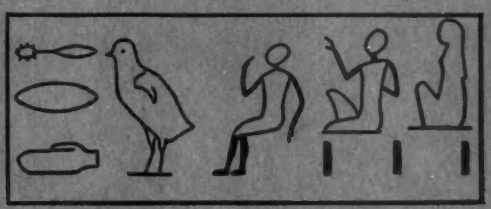
CHILD DEVELOPMENT



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DEVELOPMENT OF THOUGHT

BUFORD JOHNSON[1]

A genetic study of thought processes would include consideration of the majority of the responses of the young child during the period he is not sleeping. Since adequate verbal responses are more slowly acquired than many other forms of response that give evidence of thinking the data on the early development of the thinking process are relatively few. This lack in experimental studies is probably basic to the opposing viewpoints on thought in the child.

The contrast in viewpoints of those working in the field of child psychology is not so sharp as often appears. It is a difference in reference to the stages of development in thought. Piaget (7) is the outstanding exception through his assumption that the syllogistic form of verbalized responses is essential as evidence of conceptual thinking. He does not deny that the thinking process develops by stages from early years. He does assume that thinking is identified with verbal ability and that children do not attain the adult stage of conceptual thinking before the age of nine or ten years. He also implies that syllogistic thinking is typical of adults.

Other investigators consider the thinking process as developing from the earliest years, the stages attained depending to a great extent upon the experiences of the child. They also recognize the inadequacy of verbal responses and many techniques employed in study of thought utilize other forms of response.

Comparisons of the child with the adult in thinking cannot be conclusive from results for the same situation. To present situations equivalent with reference to previous experiences is practically impossible. It is possible to study the behavior of both groups when unfamiliar problems are presented. A comparative study of results obtained for children and adults under conditions that are certainly, in part, unfamiliar to both groups points up the developmental process of thinking.

It is admitted that the development of associative reactions or conditioned responses, and the development of discriminative abilities play a great part in the thinking of the child. In the following analysis the so-called higher thought processes are considered. Studies of the formation of concepts in early childhood and the function of conceptual thinking in the solution of problems have been increasing. The data will be analyzed with reference to the forms of responses made.

Among other definitions in Warren's Dictionary of Psychology, concept is defined as: A mental state or process which refers: (1) to more than one object or experience; (2) to one object in relation to others; when it represents a common aspect or attribute of the class it is an abstract idea.

Generalization is defined as: the process of perceiving or conceiving a general characteristic or meaning in things--responding to common aspects of specific elements in a complex situation. It is not required that evidence of a concept or of generalization shall be limited to verbal behavior.

Studies of the ability of the child to discriminate form per se - shape, some would say - independent of size, type of form, rotation or background have been made by Skeels (8), Gellerman (3) and Munn and Steining (6). Gellerman concluded that two-year-old children could discriminate form, in his study, triangularity, per se. The results of the other investigations confirm his conclusions. It is interesting to note the points of confusion for the children. When the form to which the child must respond in order to succeed differed

[1]The Johns Hopkins University.

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CHILD DEVELOPMENT, Vol. 9, No. 1 (March, 1938)

but little from the other or negative form presented, confusion arose. When a trapezoid became almost a triangle, the tip differing from the triangle only by 1/8 of an inch, the children failed though they succeeded with a difference of 1/4 of an inch.

These children exhibited symbolic behavior in the form of gestures. The head was moved, when the triangles were inverted or rotated, in a seeming attempt to look at the form in the upright form as previously presented. Speech occurred including words associated with triangles. Some children also formulated the problem verbally and in absence of instructions formulated verbally their own instructions.

Studies of the development of concepts of magnitude, of distance, and of classes with respect to common aspects or attributes show that a stable concept is attained by degrees. Few two-year-olds attain the criterion of success set by the experimenters yet many make more than 50 per cent correct responses. Some four- and five-year-olds make as few as 5 per cent correct responses. This is clearly shown in the summary from the studies on the concept of magnitude by Thrum (10) and by Hicks and Stewart (2). Both studied the concept of intermediacy in size, called middle-size, but Thrum also included the development of concepts of big and little. Hicks and Stewart gave a preliminary training in teaching the meaning of the term middle-size. A tabular summary of results is given in Table 1.

TABLE 1

CONCEPT OF MAGNITUDE, CONCEPT OF MIDDLE SIZE

Age (Years)	Hicks and Stewart		Thrum	
	No. of subjects	Per cent successful No errors.	No. of subjects	Per cent successful No errors.
2	10	10	9	0
3	10	80	16	22.2
4	10	70	9	25
5	10	60		

The number making no errors is not representative of the stages of development of the concept. This is shown in Table 2 giving the percentage of correct responses for all choices.

TABLE 2

PERCENTAGE CORRECT RESPONSES. (Thrum)

Age (Years)	No. of subjects	Total	Percentages		
			Big	Little	Middle-size
2	9	53	62.9	74	21.5
3	16	79.9	97.7	98.4	62.1
4	9	91.2	97.1	97.8	79.3

The number of correct choices tends to increase from age two to age five years, with the greatest increase from age two to age three years. The differences in percentages in the two studies is probably due to the method employed, as Thrum gave no training to develop meanings of middle-sized and employed a greater number of steps or varied series. Only one two-year-old of the 19 included in both studies attained the standard for success. Thrum

found that the concepts of big and little were well developed at each age, 10 or 62 per cent of the three-year-olds making no errors. The concept of middle size was slower to develop and more stable at age four. Six children of the 35 made no errors in any choice.

The influence of experience was manifested in the decrease in errors after initial trials in the series. Hicks and Stewart found that 68 per cent of the errors made were in Series 1. Gellerman found similar results in perception of triangularity. Until a child is confronted with a situation demanding the perception of relative size or form there is confusion in setting an objective in his response. Children often set objectives for themselves. This is illustrated by responses made in a study in progress by Kagy (4) on development of concepts which required selection of objects on basis of common attributes. The classifications included: Two-legged and four-legged animals; Ground objects; Water objects; Air objects. The child selected a picture of an object and placed it in either one of two boxes. No reference to the basis of selection was given. Each series of 10 cards presented included 5 cards having no relation to the classification problem. Records were kept of the verbal responses accompanying the placements.

The range of ages was 30 to 114 months. The percentage of correct responses for all series is given in Table 3.

TABLE 3

AGE DIFFERENCES IN PERCENTAGE OF CORRECT CLASSIFICATIONS. (From Kagy)

Age (Months)	No. of subjects	Percentage correct of total of 40 selections
30-41	6	8
42-53	15	27
54-65	7	61
66-77	9	73
78-89	11	75
90-101	12	80
102-114	4	94

The results show a beginning comprehension of classification by common characteristics at the age of 3 years and a rapid increase from 4 to 5 years of age. The concepts are well stabilized for the majority of children from 5 years upward.

The objective of the child in his placements are illustrated by the verbal responses. In presentations of land and water and air objects in varying combinations other classes were made as the following remarks indicate.

3 years, 6 months. Man riding on tractor, Woman riding in cart, with wheels; without wheels.

4 years, 6 months. Things to ride in. All things not in water. With wheels--go fast.

5 years, 6 months. All pull something. Some wheel and some have feet.

6 years, 6 months. I put riding pictures together. All people on ground together. All wheels but little boy--He has legs instead of wheel. Numbering began at this age as, "2 and 4 go together".

7 years, 6 months. All something to ride in. All things that move. All have engines.

In the classification of animals with reference to two or four legs, the following illustrations show a variety of common aspects perceived in forming classes:

3 years, 6 months. Teeth to bite and eat.
4 years, 6 months. Large long necks; Large ones together.
5 years, 6 months. All birds; elephant so slow like an ostrich. All big like deer.
6 years, 6 months. There were little and there were big.
7 years, 6 months. Deer runs fast--so can girl if she wants to. Not birds and humans but animals. Duck family.

Several children classified by feathers or fur commenting upon the reason for choice. When human figures were to be placed a problem arose. In solving it the two-legged class was made. In a series to be classified according to water objects in contrast with land objects the picture of a woman swimming was included. Hesitancy arose and the child said: But she goes on land too. A child's interpretations are often valid and the response correct according to his objective.

In studies of problem solving it has been observed that the stages of solution are similar for children and adults. Gellerman (3) concluded from his work with the Double Alternation Problem that the human subjects, adults and children, exhibited the same general stages of learning as did the monkey. Though the human subjects performed more successfully and could extend the problem to a series of greater length the stages in learning were similar. The ranges of trials required for success showed marked overlapping in age from 6 years to 23 years of age. Two children 3 and 4 years of age became tired of the problem and were excluded.

Matheson's (5) study of Problem Solving behavior in children from 2 to 4-1/2 years old also showed that at the ages under three years solution was not attained, the child often making no response to the unfamiliar setting. At age four, 62 per cent were successful. The verbalizations give interesting evidence of the child's thinking. There were cases in which the child used or suggested other solutions than the methods provided. In illustration: If there was only a block here then I could step. Maybe I can get a chair.

One child climbed over the railing. Another who failed was asked: How do you suppose Bobbie got the cookie? He explained in such a way as to give evidence of knowledge of solution but said "I can't do it."

Hazlitt (1) tested children and adults on the ability to make exceptions. She found no real difference between the thought processes of the child and of non-scientific adults. The stages of thought in making an exception are of interest. The child makes it practically but is unable to formulate it; at the next stage he formulates it but does not use the word "except"; by the age of seven years the word "except" is spontaneously given. This difficulty in verbalization of the thought is characteristic of the young child. A similar difficulty occurs with adults in response to unfamiliar situations.

Donald Snygg (9) in a study of the relative difficulty of mechanically equivalent tasks offered an opportunity to 88 college students to discover a principle for cancellation of figures. Forty reported the principle of "cancel all figures with curved lines" and were superior in time of performance; 21 used the concept "three circles, an oval, and a do-funny", and were intermediate in performance; 27 reported no principle. Of this last group only 1 subject was able to perform the task as quickly as the average time for the group deriving the principle. Snygg also found that sixth grade children and graduate students having discovered a principle in one task were able to carry the method over to new tasks. In the task of completing series of numbers there were marked differences among the graduate students in time required and in relationships recognized.

After presenting the number series used by Snygg to 11 graduate students in psychology, I presented another series for which algebraic formulae offered a

principle of completion. Instructions and the series given were as follows:

> You are to be given a number series to complete. At the end of each series three or four lines will be found. You are to place a number on each line to complete the series in accordance with a principle underlying the order of the series.

Number of Series	Number Series										
I	1	1	2	6	24	120	720	___	___	___	
II	54	6	40	5	28	4	18	___	___	___	
III	4	12	9	9	24	16	16	___	___	___	
IV	9	25	34	16	36	52	25	___	___	___	___
V	8	36	54	27	27	108	144	___	___	___	___

Results of the number series list are given in Table 4.

TABLE 4

RESULTS FOR NUMBER SERIES

Individual	Series					Number of series correct
	Three items per test			Four items per test		
	I	II	III	IV	V	
	Number of items correct					
a	3	1	0	0	0	1
b	3	0	2	1	0	1
c	3	3	2	0	0	2
d	3	3	0	4	0	3
e	3	2	0	4	0	2
f	3	3	2	2	2	2
g	3	3	2	3	0	2
h	3	3	2	4	0	3
i	3	3	0	0	0	2
j	3	3	2	3	0	2
k	3	3	2	4	2	3
All individuals Number of series correct	11	8	0	4	0	23

It was apparent from the records that trial and error methods were frequently used for each number to be placed. Many failed to formulate a principle and few changes in procedure from problem to problem were made by an individual. The simpler problems for which arithmetical analysis was evident were more readily solved. All failed on the final series.

After completion of the series the papers were collected and a similar blank given with the request to write in algebraic form the principle of completion employed. Some indicated that no formula was derived originally. In some cases a new formula was written and in other cases a formula was given that was faulty in comparison with their own solutions. Percentages of incorrect formulae ranged from 22 for one series to 66 for another.

An ingenuity problem, illustrated in Figures 1, 2, and 3, was given to eight of this graduate group and to ten undergraduates in a class in psychology. In Figure 1 is shown a cube on which the faces are lettered (a front, b left, c back, d right, e top, and f bottom) and which has been cut in sections. In the illustration it is set on face f. The students were asked to mark the cubes in Figures 2 and 3 so as to show the sections as they would appear if the cube illustrated in Figure 1 were: (2) set on face d, (3) set on face e. The results are given in Table 5.

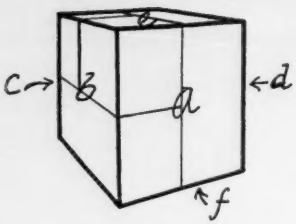

Fig. 1

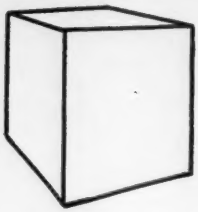

Fig. 2

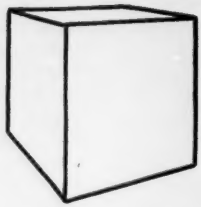

Fig. 3

TABLE 5

RESULTS FOR ROTATED CUBE TEST (Percent correct)

Individual	Figure 2	Figure 3	Individual	Figure 2	Figure 3
	Graduate Group			Undergraduate Group	
a	80	40	1	100	100
b	omitted	omitted	2	80	40
d	80	40	3	100	60
e	80	40	4	80	0
g	100	100	5	60	0
h	80	100	6	100	100
i	100	100	7	omitted	omitted
k	omitted	omitted	8	100	100
			9	80	40
			10	100	omitted

The mistakes made by both groups are similar despite the experience of the graduate group with varied tests and experiments. Faces were usually marked correctly. Errors and omissions occurred in marking lines for sections. Drawings on the sheets given showed many trials without a preceding formulation of the problem and attempts at marking sections without recognition of rotating effects.

The comparative analysis of the conceptual thinking of children and adults in unfamiliar situations shows similarity in individual differences in selection of procedure. This procedure is determined in part by previous experiences in development of concepts and in application of principles to solution of problems. The studies of children give evidence of the early development of concepts and the ability to respond to the relative differences or similarities in situations presented. The implications of these studies point up the importance of providing experiences for the child that offer advantageous conditions for development of thought. It is evident that many adults have not developed their potentialities in thought. The child is less hide-bound by traditional forms of response. The procedure selected as in classifying according to a common characteristic often differs from the conventional adult objective. In unfamiliar situations the adult often reverts to habitual forms of response which are repeated though previously found unsatisfactory. With repetition more logical modes of attack are made. The less circumscribed responses of the child based on a principle in selection should be conserved. It is important that experiences be provided that give the opportunity for and motivate toward the development of thought.

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A STUDY IN INFANT DEVELOPMENT

ALMA FRANK

The interest which led to this study arose from observing, over a period of years, a gradual diminishing of well-coordinated movement in young children. The children were attending nursery groups in progressive schools. At the age of two, when they entered school, they apparently possessed a degree of physical coordination which by the end of the third year had notably diminished; by the end of the fourth year this coordination had given way to definite well-established postural habits - rigidly fixed positions of certain parts of the body. These habits inspire the question: Is their presence related, as it seems to be, to the disappearance of the smooth and harmonious flow of movement which the two-year-olds possessed?

A recent study (4) of posture in the young child, directed by Billie L. Crook, physiotherapy supervisor for the crippled children's division of the State Department of Education of Texas, presents excellent illustrations of these postural habits. The majority of the children came from homes of university faculty members. The total number of children were divided for study into groups according to sex and age. The following quotations are taken from the study:[1]

> "To summarize points of contrast, we might say, the head of the two-year-old child is still erect; the head of the three-to-five-year-old is usually forward; the scapulae of the two-year-old lie flat on his back. The scapulae of the three-to-five-year-old are usually winged; at two years the sacral angle is very slight; at three to five it is increasing markedly; the abdomen of the two-year-old is prominent, but not often accompanied by other postural faults; the prominent abdomen of the three-to-five-year-old is accompanied by other postural faults; the knees of the two-year-old are held easily and normally; the knees of the three-to-five-year-old are usually pushed back or hyper-extended to maintain the balance of the protruding abdomen; it is impossible to judge posture while the child is clothed.
>
> "The best postures were found among the two-year-old children and the worst posture in their group was as good as the average in the other groups.
>
> "From our study the indication seems to be that the poor alignment becomes more pronounced as the child grows older.
>
> "The question now resolves itself into this one problem: Can we prevent the development of these postural faults of the four-year-old by starting with the child when he begins to walk? Could we not teach him to walk without thrusting his knees backward? Could we help him to relax his tight hip-flexors by exercises and games directed toward this end? Could we teach him to keep his weight forward and avoid the stretching strain put on the ham strings by a back-knee position?"

Such questions involve problems of time and technique, fundamental problems in education. The point of view, however, from which they are being attacked today by leading educators indicates a more fruitful conception than is implicit in the framing of the above questions.

This broader conception is presented by William Heard Kilpatrick, Professor of Education, Columbia University (9). In his paper,[2] which contains such sub-titles as "The Work of Science," "The Nature of Behavior," "Principles of Learning," he writes:

> "Still further, not only is the whole organism thus involved in each

[1] Permission granted by author to quote and to reproduce silhouettes from this study.

[2] Permission granted by Teachers College, Bureau of Publications to quote from this paper.

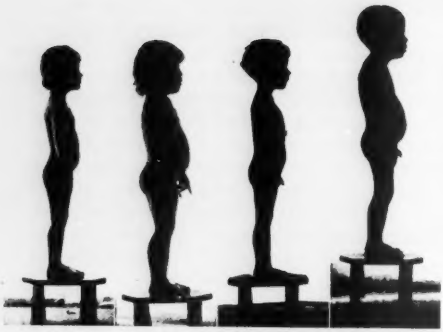


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Groups I and II
Girls and Boys
2-1/2 Years Old

Groups III and IV
Girls and Boys
3-1/2 Years Old

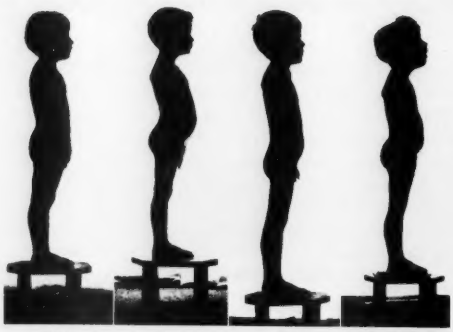


Fig. 5 Fig. 6 Fig. 7 Fig. 8

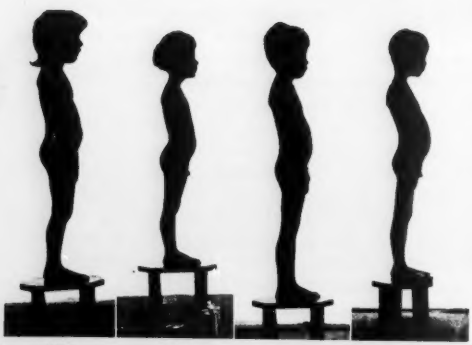


Fig. 9 Fig. 10 Fig. 11 Fig. 12

Groups V and VI
Girls and Boys
4-1/2 Years Old

learning experience, the environment also is involved. Indeed, the relationship between organism and environment is uniquely close. According to Haldane 'an organism and its environment are one, in the sense that though we can distinguish them we cannot separate them unaltered, and consequently cannot understand or investigate one apart from the rest'. These are strong words, but they appear to represent the trend of competent thought. Learning, from this consideration, joins the organism - here the human self - with the environment in a new and intimate fashion. Any organic activity is as much an affair of the environment as it is of the organism. Any habit of a child belongs as truly to the situation as to the child, for it joins both together. And 'the situation' is the actual total situation in all its particular manifestiations to which the child is in fact sensitive. In a time sense, any significant instance of learning thus joins up in a way new for the child, indefinitely many parts of the situation at the same time that it remakes the child in indefinitely many aspects. Learning becomes thus immensely far-reaching and we see the more clearly how inadequate - nay, how hazardous - are those procedures and those studies which attempt to base themselves on single and isolated learnings. The whole child with all his effectual part now actually located in a present concrete situation with all its effectual connectedness - this is the only unit. Anything less is an abstraction, a part only. Conclusions based on such abstractions need not elsewhere be valid, and treatment proposed under such conditions may well be harmful. Difficult as are the demands herein made, we dare not disregard them."

This conception applied to the problem of the physical well-being of the child means a procedure vastly different from one which aims to teach the child a long list of isolated learnings such as not to thrust his knees backward, to relax his hip-flexors, etc. On the contrary, it means a careful survey of the situation which children, such as these represented in the silhouettes for instance, are meeting thus inadequately. To be specific, it means to what influences is postural control particularly susceptible and which of these facilitate maintenance of erect posture and which have an opposing effect? It means also what states of readiness for guidance do we find within the organisms whilst it assumes erectness and which form of guidance works best under which conditions?

"Under which conditions" is an exceedingly important factor. It is emphasized by Kilpatrick in the above-mentioned paper (section called "The Work of Science") as follows:

"In science we study carefully the recurring sequences which nature presents: how stones fall, when water freezes and boils, how gases behave. Until recently, under the influence of Newtonian physics, the regularity of these sequences has unduly impressed the modern mind. It begins now to appear that we have in connection overlooked two things.

"For one thing, these regularities are not as exact as once we thought; they seem rather to be statistical averages. For another, we formerly disregarded the "if" aspect of these sequences: <u>if</u> thus-and-such conditions prevail, <u>then</u> will such-and-such state of affairs follow. This "if" aspect may be, and often is, in our hands. If so, it is we who are to say whether the "thus-and-such" antecedent conditions are to prevail; and, under such conditions, it is we who thus bring about the "such-and-such" conclusions; or, as some would prefer, "nature" does it at our bidding. So conceived, these "laws of nature" present simply certain dependable expectations that we can within limits use to our ends. In this newer conception of science we thus get not a reign of law to bind us, but wider tools for extending our control. Through these we gain freedom, not lose it."

This conception represents a significant advance in education. Since its applicability rests upon observed facts in science, educators turn to the recent research on infant development for the solution of the problem with which this study is concerned.

Claude Bernard (2) has referred to some experiments as "groping experiments - experiments to see." Although he refers to experiments in physiology and therapeutics, the phrase "experiments to see" classifies the experiment presented in this report. The intention was "to see" the effects, if any, of induced positions and of support applied by the experimenter to maintain them, upon the infant's overt somatic behavior during the period of acquiring stance and locomotion.

In order to give this experiment its proper orientation, it is necessary to discuss briefly the assumptions and experimental procedures in investigation of infant behavior and behavior growth.

In outstanding studies we find statements to the effect that it is desirable but impossible to observe the whole child comprehensively. Gesell writes (6): "It is impossible to bring the whole child under comprehensive observation and yet his entire physique must of necessity be accounted for in a full description of the behavior flow."[3] He solves his dilemma in this fashion: Since the task of verbal description is difficult, it will be necessary to describe separately the behavior patterns of different parts of the infant's body. Incidental comment will be made to remind us that these parts do not function independently but always in some dynamic and genetic relationship with all other parts. It does not follow that this dynamic relationship between varied portions of the body is equally strong at all ages and at all moments, for there is continuous shifting in the whole pattern of tensions. We shall consider in order the head, arms, hands, trunk and legs, stressing the growth changes in behavior patterning throughout the gamut of age levels. The synthetic correlation of the developmental data in these varied subdivisions must be left largely to the reader." (underscoring mine)

Dr. McGraw (11) also discusses the need to study "the whole child." She adopts a method which she describes as follows: "Systematic analyses of the changes as indicated in overt-somatic activity in the development of a behavior pattern from the time of origin until it attains maturity constitute both a feasible and a revealing method of studying the process of growth."

Both these writers adopt the method of observing growth by analyzing separately the "behavior patterns" of different parts of the body. Moreover, both admit that isolation of a behavior pattern is impossible but claim that within certain set experimental limits sufficient "behavior trends" appear to justify the acceptance of the resulting protocols as representative of growth processes. This amounts to another assumption, since there has been no attempt to test or prove the claim with comparable data from other types of experiments.

Only one type of experiment has been done, and that involves the use of induced positions as a primary experimental procedure. "Standing behavior," for instance, has been observed with the infants lifted to and supported in "standing position" from the age of four weeks. "Sitting behavior" has been observed with infants who are either pulled up by the arms to "sitting position" or by other means placed in sitting position from the age of four weeks. The same method is practiced for observing "walking behavior". What we have, therefore, is observations of various "behaviors" "or behavior patterns," in organisms who have been placed in supine, prone, standing, supported standing, pulled-to-sitting, "passive induced sitting," and other positions.

In some instances one position remains constant throughout the observation of a single behavior. In other instances the initial position does not remain

[3]Permission granted by the author to quote from "Infant Behavior".

constant, one or more other positions being induced by the examiner.

This use of imposed position is exemplified by Gesell in his chapter "The Growth of Posture" in "Infant Behavior." He writes:

> "The Second Quarter (16 to 24 weeks) Sixteen weeks marks many transitions. The infant in the second quarter becomes a propped-up as well as a supine individual .....
>
> "The Third Quarter (28 to 36 weeks) From the standpoint of postural self-dependence, this is a transitional period. For the most part he still needs props, safe-guards, and help.
>
> "The Fourth Quarter (40 to 52 weeks) The adult hands which had to aid his balance at 40 weeks are now withdrawn."

The causal relation in these experiments between the imposed position and the "need" for "props" and for "adult hands which had to aid his balance" is obvious. The reason for the need of the "props" is that the infant's position is imposed. The underlying assumption is either that the infant must inevitably be placed and supported in certain positions during postural growth or, that growth of a behavior, one aspect of which at the time of maturity of the pattern is a certain position, can be observed only while the infant is placed by the adult in this position.

With the exception of supine and prone, the positions used in these observations all require support from the examiner. The organism in some instances is supported by means of suspension, the point of support being the thorax; in other instances, by means of a combination of suspension and flat static surface; sometimes by mechanical means such as a belt and chair, the points of support being the abdomen and the back; sometimes by a flat static surface only, the point of support being the feet. This means that at various points upon the organism varying degrees of pressure or traction are supplied by the experimenter.

These facts give rise to the question: Are the responses which are possible under the particular limits set by these experimenters adequate to the vital process presumably being observed? Are these responses the spontaneous and free manifestations of growth?

In order to answer this question, an analysis of the responses must be made.

That behavior such as standing, sitting and walking is inseparable from postural activity is an accepted fact. That postural activity is enacted through the medium of neuro-muscular mechanisms and that the working of neuro-muscular mechanisms is influenced extensively by tactile stimulation and pressures upon the peripheral sensory end-organs and by stimulation of the proprioceptors arising from movement of the limbs, has been established by the experiments of outstanding physiologists. The work in this field has been well summarized by Rudolph Magnus (10) and by Charles Sherrington (12).

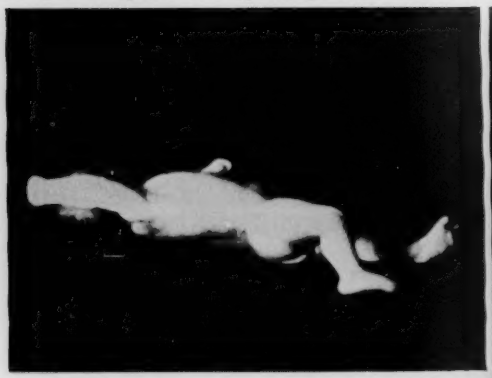
Unless nervous action in man is of a different order from that in the higher animals (and observed facts do not bear this out) (8) the configura-

Fig. 13. Standing Behavior. 4 weeks.

tion in Figure 13, (6-taken from page 85) for instance, represents not only manifestations of the growth process but also responses to the suspended position. The sagging of the head, the particular-posturing of the arms: to what extent are these due to pressures exerted by adult hands? We can ascertain this only by comparing the behavior of the infant under these pressures with its behavior when these pressures are reduced to the zero point, or to the lowest possible minimum.

The conditions and procedure in the following observations were arranged to make such a comparison possible. It was also hoped that the results, interpreted in the light of conceptions held by leading scientists and of observed facts in physiology, would suggest a method of research in infant development which will disprove the assumptions that the whole infant organism cannot be brought under comprehensive observation and that analyses of a behavior pattern, when induced positions are part of the observed pattern, "constitute both a feasible and a revealing method of studying the process of growth."

That the whole organism must be brought under comprehensive observation is actually implied in Gesell's definition of growth. He defines growth as a process which "organizes the individual." In relation to somatic behavior this can mean nothing less than action which embraces the working together of all the parts capable of responding at the time.



Figs. 14 and 15. Somatic Behavior at 4 weeks, looking at the same action from two points of view.

In this picture of a 26-day-old infant there is a certain organization of mechanisms, producing one total action configuration. In the picture of the infant (Gesell's) in standing position a similar organization does not appear. Parts which are capable of responding in the one are in the other prevented from free and spontaneous action. The difference in the dynamic relationship of the head and arms to the trunk is obvious; it is precisely the organization of the individual that is interfered with by the pressures on the thorax, axillae, and joints. If the protocols are to be representative of growth as growth is defined, the behavior of the part can be accurately observed only in the context of the total behavioral response indicative of organization.

EXPERIMENTAL MATERIALS AND METHODS

The subjects chosen for the research were living in the Home for Hebrew Infants, New York City. They were therefore of the same nationality and were receiving the same nutritional and routine care.

The home proved to be particularly advantageous for this study. Since Dr. Hess organized it and carried on research there, the infants have purposefully and consistently been unaided by adults in rolling, sitting, standing and walking. It was considered desirable to have infants who were not in their general routine life experiencing positions the effects of which were to be observed in the experimental situation.

The organization of the orphanage as a whole was also of advantage in that it provides markedly unhurried and cheerful surroundings. Each infant has a room of his own with vita-glass French door and windows opening upon an uncovered porch. The partitions of the rooms are of glass, making it possible for an infant to watch the nurses moving about as well as other infants in adjoining rooms. From day to day each nurse has the same four infants in her charge, and is requested to take time to play with them during the morning bath, which is given to each infant in his own room. The babies over four months old are brought together in the afternoon for a playtime on the floor of the reception room.

Two groups of infants were selected; one consisting of three six-months-old boys who were making efforts to roll from supine to prone, and the other consisting of three eight-months-old girls who were about to sit up while on the floor in the afternoons. These infants were all on the feeding used for normal infants and were either normal in weight or within a pound of it. Although no psychological tests were made, the babies selected were considered normal by the pediatrician.

The plan was to take moving pictures of these infants under the following two different experimental procedures, and to compare results.

Procedure No. I. The infant placed upon its back and left without further stimulation by touch or sound from the examiner.

Procedure No. II. The infant placed upon its back and then by the examiner drawn into a position which it could not itself assume without adult aid.

No lures were used in order to stimulate specific activities such as rolling or creeping. The toys the infants were using in their beds when taken from their own rooms to the examining room were carried along either by the infant, or the examiner. In the latter case, they were placed on the floor within easy reach of the child.

The photographs were always taken in the same room, which was used only for this purpose at the same time daily. The infants were taken one at a time into the examining room, undressed and placed on the floor. A blanket, mattress pad and a sheet of dark green flannel were used underneath and another sheet of flannel hung on the wall behind the infant.

In order to minimize the possibility of arousing fear reactions, the introduction of the infants to the photographing situation was gradual. Before being taken to the examining room at all, each infant had, during the previous week, spent a half hour a day on the floor of his own room. During the first week in the examining room they were not undressed, and it was only after three weeks of being on the floor daily (Saturdays and Sundays excepted) that they ceased regarding the room and the examiners and went about the activities they were accustomed to carry on in their own beds or on the floor in the afternoons. The flood-lamps were introduced during the fourth week; aside from blinking at first the infants paid no attention to them. Pictures were taken on the last day of the fourth week, and thereafter always on the

last day of the week, since it was the farthest away from the break in the routine occurring on Saturdays and Sundays.

A Bell and Howell 16 millimeter camera was used.

Attempts were made to silence the camera. They were, however, unsuccessful, and the first films taken were so full of stops and starts that no flow of movement could be seen. A metronone, which served to drown the sound of the camera, was then used continuously in the room, and the speed of the camera was reduced from 64 to 48. After this adjustment the infants did not stop or, as far as could be seen, change their activities at the sound of the camera.

Each infant was left on the floor twenty minutes a day. The photographic lamps were put on for the last ten minutes of this time regardless of whether pictures were to be taken or not, in order to keep the set-up constant.

Due to limitations of time and equipment it was possible to employ only one induced position. It is to be regretted that others also could not have been investigated.

RESULTS

In presenting the results, there are a few simple comparisons to be made.

1. When the infant was placed on his back and left without further stimulation from the examiner (procedure I), the organism as a whole did not at any time while under observation take a course through space similar to the course taken under procedure II.

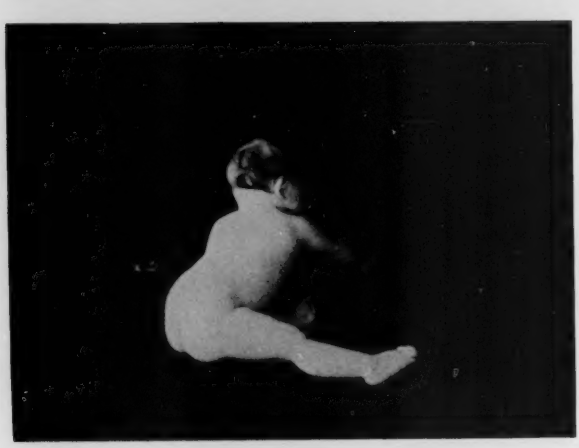
Under procedure I, the six-month infants kicked vigorously, rolled from supine to prone, or engaged in activities preliminary to rolling such as pelvic lifting, and twisting or rolling to one side and balancing there whilst swinging the upper leg back and forth horizontally. Obviously, during none of these activities did the organism move through space in a direction similar to the direction in which the infant is taken in Fig. 16.

Fig. 16. James: 6 months. Pulled to sitting by adult. Procedure II.

The infants of eight months, even in the act of sitting, likewise moved in a direction different from their behavioral course under procedure II. They

first rolled from supine to prone, then drew one leg under the pelvis, and starting from the lower back raised the trunk and head together, simultaneously drawing the leg out from under the pelvis gradually.

Figs. 17 and 18. Mary: 8 months. Attaining sitting without adult aid. Procedure I.



2. The structural configuration of the organism as a whole was different during all activities under procedure I from its structural configuration under procedure II. In both groups of infants the spine, under procedure II, was flexed to such a degree as to decrease the stature noticeably, both during the process and in the position maintained at the completion of the pulled-to-sitting activity. Neither in the process of an activity nor in any maintained position, did the infants, under Procedure I produce a similar posterior curve, thus decreasing the stature.

Fig. 19. Mary: 8 months. Sitting attained without adult aid.

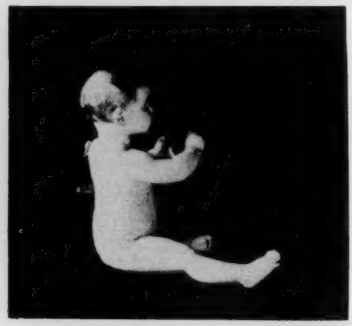
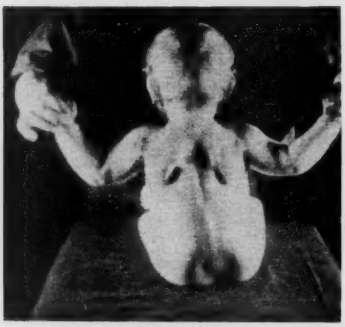


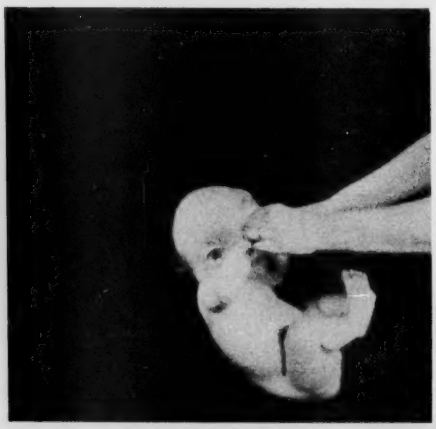
Fig. 20. Mary: Same day. Sitting as pulled-to-sitting by adult.



The drawing-in at the anterior thoracic region and the pushing down and outward of the abdominal region, both accompaniments of the posterior curve of the spine together with the decreasing of the stature, is shown in the following picture of James, a profile view taken at the same time as the picture next to it which shows him kicking vigorously.

Fig. 21. James: 6 months. Procedure I.

Fig. 22. Same; Procedure II.



3. There is a very conspicuous difference in the behavior of the muscles of the back. Under procedure I there is an even spread of contraction throughout the sacrospinales, and the back has an appearance of strength and ease. Under procedure II, contraction is apparently not taking place in the back muscles of the six month infants and in the older ones it is concentrated in the upper, middle, and lower trapezeus muscles and does not take place in the lumbar and thoracic portions of the sacrospinales, and the back has an appearance of strain.

Fig. 23. Marvin: 6 months. First complete roll. Procedure I.

Fig. 24.

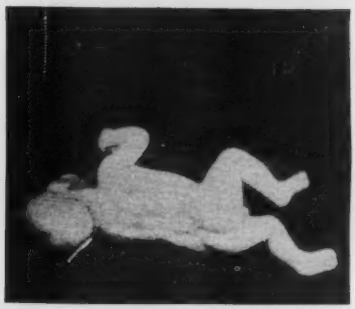


Fig. 25. Marvin: Same day. Pulled-to-sitting by adult.

Fig. 26. Carol: 8 months. Procedure I.

Fig. 27. Carol: Same day. Procedure II.

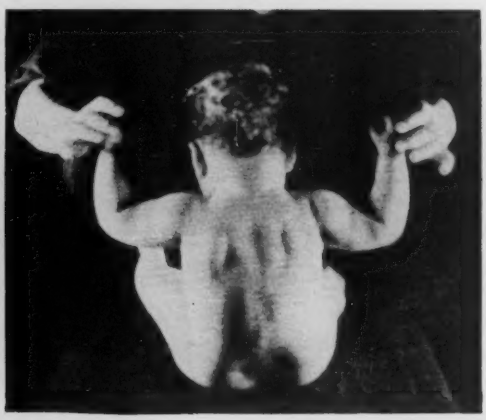


Fig. 28. James: 6 months. Procedure I.

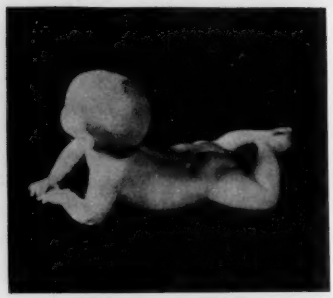


Fig. 29. James: Same day. Procedure II.

4. There is also a marked difference in the behavior of the segments in relation to the trunk and head.

In procedure II the legs are, as Gesell describes them, "helpless appendages." In Procedure I they perform an integral part of the whole movement. The difference in the behavior of the arms is quite obvious; in one case they are free to follow the head and trunk, whereas in the other, they are forced to move upward, drawing the trunk and head along after them.

5. Under procedure II, the head sags; under procedure I, it is usually extended when the spine is extended, and it never sags.

We may say, then, that the effects of the induced pulled-to-sitting position upon the somatic behavior of these infants occur in the direction in space taken by the organism, as a whole, in the structural configuration of the organism, in the relation of the parts to each other in use, and in the distribution of tension.

DISCUSSION

The effects pointed out above are overt manifestations apparent to the untrained eye. There are others less easily recognized. An approach to the latter can be made through the observations and resulting concepts of those experimenters who have worked intensively with neuromuscular mechanisms. Since somatic behavior and the working of neuromuscular mechanisms are inseparable, the interpretation of one must be made by means of an understanding of the other.

G. E. Coghill's (3) well-known work on Amblystoma gives us an exceedingly clear picture of the working of the mechanism in a simple organism. He concluded that behavior develops in Amblystoma by the expansion of a primarily integrated total pattern of action and the individuation of partial patterns within the total pattern. He also states that whether or not behavior in other vertebrates follows this plan of development has become a question of leading interest in the study of behavior.

Work similar to Coghill's has been done with the human fetus. In a review of the general responses of human fetuses as shown by Minkowski and others, Davenport Hooker (7) states: "The interpretation which I would give to the results of human fetal responses is, of course, quite clear. Every bit of evidence, from the work of Minkowski and from the other unfinished studies of which I have been speaking, indicates that the responses of human fetuses to tactile stimulation follow a Coghillian sequence; first, the expanding total pattern;

then, the rather rapid process of individuation of specific reflexes from that total pattern."

"The type of stimulation used in fetal work is of great significance. It may be remembered that Coghill used a human hair on Amblystoma embryos. Angulo used a coarse hair. Windle used metal and fiber needles, cactus spines, and other blunter instruments. Carmichael used many types of stimulators, but chiefly a metal or fiber needle, a coarse hair or a brush.

"I have recently been using a series of graded stimulators, human and horse hairs, which are just stiff enough to maintain, as they bend, a delicate chainomatic balance against weights of 10, 25, 50, or 100 mgm. ..... Among others, Minkowski, in working with early human fetuses, has warned that rigid stimulators clearly cause direct muscle stimulation. In my opinion, 'weighted' esthesiometers, of the type mentioned, are the only proper method of applying stimulation to secure reflexes. ..... After thirty years of embryological experimental work, it seems to me advisable to use stimulators which offer the least possibility of producing an unintentionally strong stimulus."

The significance of the results obtained by these men for experimental work on human infants lies in the implication that there exists in the infant organism as well a "primary mechanism of integration" and that the infant's somatic behavior follows the same plan of development as has been observed in Amblystoma and the human fetus. If this is the case, it becomes essential, in order to observe behavioral manifestations of the working of this mechanism, to heed Minkowski's warning to avoid direct muscle stimulation.

It is important at this point to call attention to the photographs in the section of this paper called "Results", - taken under procedure II. The direct stimulation of the shoulder girdle and arm muscles is obvious; some of the specific effects have been mentioned. It remains now, in connection with the above writings, to draw attention to the fact that the total behavior of the organism under procedure II is <u>not</u> a manifestation of the working of a "primary mechanism of integration." Unity is lacking. The behavior under procedure I, however, shows a comparative unity, which is in evidence in Figs. 30-32, as well as in all other pictures of the infants under procedure I.

Fig. 30

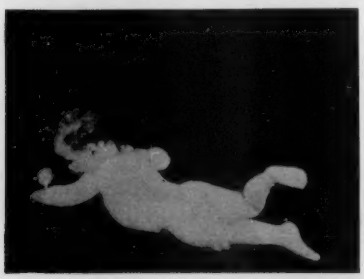


Fig. 31.

Fig. 32

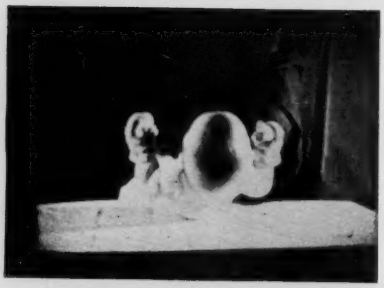


Fig. 33

Fig. 34.

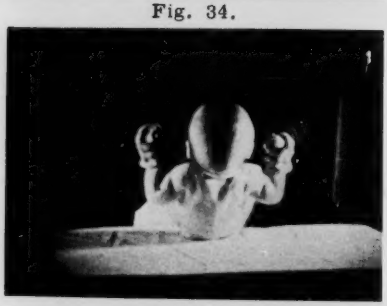


Fig. 35

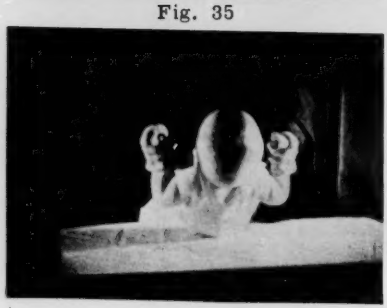


Fig. 36

Fig. 37

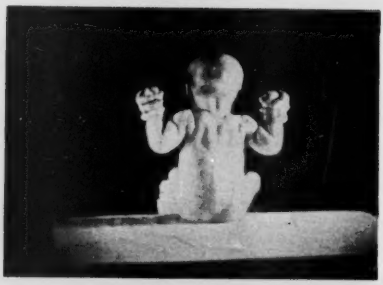


Fig. 38

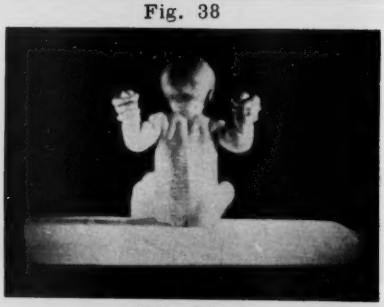


Fig. 39

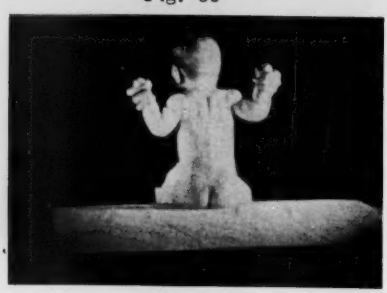


Fig. 40

In regard to the relation between such unity and the mechanism of total integration, Coghill writes: "The mechanism of total integration tends to maintain absolute unity and solidarity of the behavior pattern. The development of localized mechanism tends to disrupt unity and solidarity and to produce independent partial patterns of behavior. In the interests of the welfare of the organism as a whole, partial patterns must not attain complete independence of action; they must be held under control by the mechanism of total integration. Parts become integrated with each other because they are integral factors of a primarily integrated whole, and they remain integrated, and behavior is normal, so long as this wholeness is maintained. But the wholeness may be lost through a decline of the mechanism of total integration or through the hypertrophy of mechanisms of partial patterns."

With the above quotation in mind, let us look at Figs. 33-40, a series of photographs which illustrate, I believe, "partial patterns" of behavior produced as a result of work done upon the organism by the experimenter. That the infant's neurological mechanism will not of itself attempt a movement in the direction in which the organism is here being taken suggests that the directive force applied by the experimenter is bringing about this intense local contraction in the shoulder-girdle region, a development which will not take place whilst the integrating factor within the organism itself is permitted to function, and by means of its functioning to direct the behavior. As has been pointed out, the infants in this experiment, left to their natural abilities, showed no such undue contractions, or tensions in spots.

The work of Sherrington and Magnus on reflexes is classic, and the results are now employed by the medical as well as the scientific world. Magnus, while working with higher vertebrates, happened upon a phenomenon which was of great interest to him and which led to definite conclusions concerning the relation of certain reflexes to postural activity. The brief description he gives of how he chanced upon the initial observation which led him on in a certain direction may prove a help to the reader in understanding the ultimate result. Magnus (10) writes: "The limbs of mammals, as of other vertebrates, are built up of bony segments, linked by a complicated arrangement of ligaments and moved and fixed by muscles; faciae also play a role. The whole system is easily movable in different directions. Our problem is to explain how such a moving limb is at times used as an instrument for very different purposes (such as scraping, scratching, fighting etc.) and moved freely in all joints, whereas at other times it is transformed into a stiff and strong pillar, which gives the impression of being one solid column, able to carry the weight of the body .....

"We were confronted with this problem during the investigation of decerebellated animals, which had been operated upon by Dr. G. G. J. Rademaker, and of which the condition of muscle-tone had to be followed during the course of many months. It soon became evident that this was not a simple task, and that the state of tone of a limb at any given moment depended greatly upon the way in which the tone was investigated. If, for instance, the dog is lying down in the lateral position and the resistance of one forelimb against passive flexion is measured with the hand and fingers flexed, often no resistance can be felt. But if the latter are extended and pressure exerted against the pad of the foot, then the forelimbs become strongly extended and can hardly be flexed at all. The same difference can also be demonstrated in intact animals. We therefore decided to make a more detailed investigation of these reactions."

In referring to the results of these and other investigations Magnus (10) states, "the chief result of these investigations is that posture is an active process, and is the result of a great number of reflexes, many of which have a tonic character."

Another chance discovery made by Magnus (10) is of importance here, and is described by him as follows:

> "General static reactions in the decerebrate animal can most easily be induced by changing the position of the head. This was discovered by chance. Many years ago I prepared a decerebrate cat with cross-section of the low thoracic cord, in order to study some reflex reactions of the tail muscles. For this purpose I brought the animal from the lateral into the supine position and noticed to my surprise a slow but very strong 'pathetic' extension of the forelimbs, which disappeared when the animal was again placed upon its side. Other changes of position evoked also tonic reactions of the forelimbs. Subsequent repetitions of the same experiment showed that various animals reacted differently. A long experimental analysis, in which I was joined by my friend, De Kleyn, was necessary until we understood the phenomenon completely. As usual the result was comparatively simple. It is possible, by giving different positions to the head, to change the distribution of tone in the whole body musculature, and (as far as decerbrate preparations are concerned) especially in the above-named group of anti-gravity muscles. The most striking reactions appear in the extensors of the limbs and in the neck muscles. The effects observed are the result of the combined reflexes from the labyrinths and from proprioceptive neck-receptors, and as the relative strength of these two influences vary from animal to animal, the different results of subsequent experiments can be understood. In this way it is possible to impress upon the whole body different adapted attitudes by changing only the position of the head..... The mechanism as a whole acts in such a way that the head leads and the body follows."

The work discussed so far has been done on embryos and experimental animals. It remains now to draw attention to experimental work on the intact human organism, the importance of which work has been realized since clinical evidence proved that neuro-muscular activity in man as well as in the higher animals is reflex in nature (12). Such investigation was carried on over a period of years by F. M. Alexander (1). In the introduction[4] to Alexander's "The Use of the Self" John Dewey writes: "Any sound plan must prove its soundness in reference both to concrete consequences and to general principles. What we too often forget is that these principles and facts must not be judged separately, but in connection with each other. Further, whilst any theory or principle must ultimately be judged by its consequences in operation, whilst it must be verified experimentally by observation of how it works, yet in order to justify a claim to be scientific, it must provide a method for making evident and observable what the consequences are; and this method must be such as to afford a guarantee that the observed consequences actually flow from the principle. And I unhesitatingly assert that, when judged by this standard, that is, of a principle at work in effecting definite and verifiable consequences, Mr. Alexander's teaching is scientific in the strictest sense of the word. It meets both of these requirements. In other words, the plan of Mr. Alexander satisfies the most exacting demands of scientific method." Alexander, as did Magnus, chanced upon a combination of reflexes which effected the concerted activity of the entire body musculature. He discovered through extended experimentation that the head and neck provide the controlling influence in producing this particular reflex action, and that a certain relativity of the head to the neck and head-and-neck to the torso brings about a distribution of well directed instead of

[4]Permission granted by E. P. Dutton to quote from John Dewey's introduction to F. Matthias Alexander's "Use of the Self."

misdirected energy throughout the entire body musculature, by means of which all parts are brought into co-ordinate use. This certain relativity Alexander named the "primary control," since he found that, when actively present in any individual, it conditions all sensory-motor reactions, as well as brings into cooperation the combination of reflexes necessary to the gradual raising of the standard of use of the neuro-muscular mechanism.

> As Alexander puts it: "I wish to make it plain that whenever I use the phrase 'use and functioning' in relation to the human organism, I do not indicate by it mechanical activity as such, but include in the phrase all manifestations of human activity involved in what we designate as conception or understanding, withholding or giving consent, thinking, reasoning, directing, etc. For the manifestation of such activities cannot be dissociated from the use of the mechanisms and the associated functioning of the organism." The great importance of this is the discovery of a primary control of the reflex action by means of which the use, or "manner of use," of the organism as a whole is influenced. This is not only implicit in his discussion but also in the new trend in modern science which puts emphasis upon the study of intact living organisms in differing media. A presentation of this trend can be found in L. K. Frank's paper (5). With this emphasis, it becomes necessary to have both a criterion by which the extent of integrative action characteristic of the organism under observation can be ascertained and a technique which will facilitate the functioning of the "mechanism of total integration." In dealing with the human organism, the only possible criterion is inherent in the use of the primary control of that organism: this because of the differentiation of manifestations arising from apparently similar conditions, and the dissimilarity of the changes necessary in the conditions from time to time during procedures which can lead to the eradication of these manifestations.

In experiments such as the one presented in this paper the use of the hands calls for special criticism, for it is a demonstrable fact that the human hands are one of the most powerful stimuli to habitual reaction when they touch another human being. Hence any person who attempts to help or aid an infant in such experiments as we are dealing with should be well experienced in such use of the hands, while realizing a high standard of co-ordinated use in himself through the employment of the primary control. It can be demonstrated that the results which accrue in this connection from the use of a particular person's hands will be in accordance with the standard of co-ordinated use of the whole mechanism which makes the use of the hand possible. The photographs presented here afford proof to this effect and the most casual observer cannot fail to be struck by the obvious mal-co-ordination. Thus it appears that a problem of large scientific and educational significance, when approached experimentally, yields material that points to the need for reorganizing the concepts of motor activity and the study of motor development. The implications of this for education are far-reaching.

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AGE DIFFERENCES IN BEHAVIOR AT THE NURSERY SCHOOL LEVEL[1]

LaBERTA A. HATTWICK AND MOLLIE KROM SANDERS

Laymen and technicians alike are interested in finding and understanding distinguishing characteristics for the different age levels. "What are the abilities and interests of the 2 year old? What can I expect of a 4 year old in the way of self help? In social behavior? What stages, if any, do children go through as they mature? Are certain behavior difficulties characteristic of certain age levels or stages of development?" Both in gathering of laymen, where children are being discussed, and in scientific circles, where research projects are being planned, questions such as these occupy a conspicuous position.

As evidence of the above fact, it is interesting to note that no other factor has been more consistently included in studies of children than that of age (1, p.41, p.139). Most of these studies, however, have dealt with a single, rather isolated aspect of behavior and have made the age analysis secondary to other aims. Curiously enough, attempts to make comprehensive studies of age differences per se -- especially at half year intervals as in the present report -- have not only been scarce but have usually been discouraged and disapproved. Environmental factors and individual variations in behavior have been considered too great to justify the use of such fine increments as these.

Practical demands would now seem to justify the more direct and detailed approach to the study of age differences. Today, more than ever before, children of 2, 2-1/2, 3, 3-1/2 and 4 are entering schools. Teachers are faced with the task of guiding these children so as to insure optimal development. In such a situation the teacher needs some understanding of age differences within the nursery school level. She needs to see these differences in perspective, not just as isolated facts assembled from here and there. True, the findings which research can supply may not hold for individuals, they may not even be sharply defined for groups, but even so they should provide a helpful starting point for a program which attempts to further developmental needs.

The present study, which represents one aspect of a larger project, was made to determine what behavior difficulties and personality characteristics, if any, do distinguish children at 2, 2-1/2, 3, 3-1/2 and 4 years of age. It was hoped that the study might throw some light on the developmental aspects, if any, of the so-called behavior difficulties of preschool children.[2]

SOURCE OF MATERIAL

Subjects

The main group of subjects for the present study consisted of 555 children

[1]Grateful acknowledgments for this and for a companion article on sex differences (see Child Development, December, 1937) are hereby extended to Rose H. Alschuler whose cooperation has been most valuable in these and various other studies made by the senior author. Collection and treatment of data were made possible by the cooperation of the staffs and associated personnel of the WPA Nurseries of Chicago and the Winnetka Public School Nurseries. All of these nurseries are directed by Rose H. Alschuler.

[2]As one aspect of the present study an attempt was made to abstract and synthesize isolated age findings for behavior at the pre-school level. Wide differences in terminology, methods, age groupings, etc., made it impossible, however, to complete this work. The analysis by Jones and Burks (1) is recommended instead.

who were distributed by age and sex as follows:

Age	Number of Cases		
	Boys	Girls	Total
2	10	13	23
2½	34	40	74
3	74	89	163
3½	98	93	191
4	52	52	104
Total			555

All of the children studied were enrolled in nursery schools. Although American children were predominent, the group also contained Negroes, Italians, Mexicans, Poles and children of mixed European extraction. A previous study (2) contains a more detailed description of the first 335 cases. A comparison of paternal occupations for this latter group with the U.S. census for 1930 revealed a marked similarity in distribution with the exception of the agricultural group which was not represented among the experimental subjects.

Length of Nursery School Attendance

It was necessary to obtain the present data in the fall of two successive years. Since many of the schools involved remained open twelve months a year --and children were not infrequently dropped and replaced at irregular intervals throughout that period-- it was impossible to secure enough cases for comparison when the age levels were equated for time in nursery school. Thus nursery school attendance is a variable factor which tends to operate in favor of the older groups. The median difference in length of nursery school attendance between any two successive age groups was found to be one month, while the greatest difference between any groups (that between the 2 and 4 year levels) was approximately five months.

Since this difference might invalidate the present findings, a check on its influence was secured before further comparisons were made. This check consisted in comparing the present, total set of data, with age data matched for nursery school attendance. Matched data were available from a previously published report (3) for 1) forty 3 and 3-1/2 year olds and sixty-two 4 and 4-1/2 year olds who had been in nursery school six weeks or less and 2) an equal number of children of the same ages who had been in nursery school seven months or more. For comparative purposes the present age data were thrown into the same age groupings as the previously published material.

The two sets of data in which age groups were equated for nursery school attendance were found to yield the same trends in behavior between successive age groups as do the data presented in this report. The actual percentages in these three sets of data were also comparable, the average difference between the present and the six weeks' data being 6 per cent and that between the present and the seven months' data 7 per cent.[3]

The different sets of data did not agree on "secretly takes property of others" (either to any or to an habitual degree) and "habitually asks unnecessary help". These traits have been omitted from the age comparisons in the present report.

The matched data revealed no age difference for "wriggles a great deal when sitting". Since they did not actually contradict the present findings, and

[3]Other comparisons (in percentages) follow:

	6 weeks' group	7 months' group
Range of differences	0-18	0-25
50th percentile	5	6
75th percentile	8	10

since the present data are consistent for both "any" and "habitual" groupings this trait has been retained.

In general, the variable factor of nursery school attendance does not seem to have materially influenced the present results. When we stop to realize that the difference in nursery school attendance between successive age levels was only one month it seems logical that any effect or this factor would be slight.

Method

The data for the present study were obtained on a special rating scale. The general scope covered by the items includes eating, sleeping habits, elimination, nervous tendencies, speech, fears, relation to adults, relationships with other children, and general personality and emotional reactions. Specific items are indicated in Table I.

TABLE 1

FREQUENCY OF BEHAVIOR HABITS AND PERSONALITY TRAITS IN PRESCHOOL CHILDREN[1]

Behavior[2]	No. Cases[4]	Frequency Any	Frequency Marked	Behavior	No. Cases	Frequency Any	Frequency Marked
Asks unnecessary help	569	.83	.20	Twists hair	569	.49	.08
Leaves tasks incomplete	570	.83	.27	Fears high places	566	.48	.09
Wastes time at routines	569	.81	.30	Daydreams	571	.47	.15
Ignores requests	570	.76	.25	Avoids play with others	570	.46	.11
Stays awake long at nap	486	.75	.37	Chew objects	569	.44	.06
Dawdles at meals	520	.73	.33	Holds body tense	568	.43	.08
Wriggles when sitting	568	.69	.23	Rushes into danger	570	.38	.06
Looks for praise	571	.68	.16	Relates fanciful stories[3]	569	.38	.06
Criticizes others[3]	570	.68	.13	Lisps or lalls	555	.38	.16
Refuses to comply	569	.66	.17	Sucks thumb, day or night	569	.37	.10
Refuses to share	569	.64	.13	Fears strange people	564	.37	.04
Avoids risk[3]	571	.63	.16	Shrinks from notice	570	.36	.07
Resists at rest	561	.62	.27				
Seeks attention[3]	567	.62	.18	Is jealous	571	.35	.03
Cries easily	569	.62	.15	Bites nails	569	.32	.04
Picks nose	568	.62	.11	Secretly takes property[3]	570	.30	.03
Plays with fingers	569	.61	.20	Has temper outbursts	560	.29	.03
Refuses food	519	.60	.16	Breaks toys[3]	571	.28	.03
Grabs toys from children	553	.59	.15	Twitches[3]	569	.28	.04
Laughs, squeals, jumps[3]	569	.59	.22	Handles sex organs	568	.28	.04
Bosses others	570	.57	.14	Wets self during day	568	.26	.05
Gives in too easily	571	.57	.09	Fears animals	551	.24	.02
Is hard to reason with	570	.56	.15	Fears loud noises	558	.23	.02
Sulks	572	.55	.11	Misrepresents facts[3]	571	.22	.03
Remains tense at rest, nap	560	.55	.12	Stutters	557	.19	.05
Stays close to adult	570	.54	.11	Wets self during nap	503	.19	.03
Slurs or speaks indistinct	566	.51	.24	Desires to be fed	521	.13	.03
Stays awake during nap	487	.51	.16	Awakens crying	477	.12	.01
Attacks others	571	.50	.09	Mistreats animals	551	.11	.00
Grumbles or whines	572	.49	.10	Regurgitates food	521	.09	.01

[1]Traits in the above table which revealed no consistant age differences and which are not discussed in the following sections are: "resists at rest", "handles sex organs", "attacks others", "mistreats animals", "sulks", daydreams", "twists hair", "chews objects". It is of interest that these are traits all of which often reflect nervous tensions or emotional insecurity.

[2]"Any" occurrence has been used as the basis for ranking behavior in the table.

[3]Complete wording of these items on the rating scale is as follows: Goes to adult, with criticism of others; avoids activities involving risk; seeks attention by calling or showing off; laughs, squeals, jumps around excessively; relates fanciful stories as real; secretly takes property of others; breaks toys, tears books, marks furniture; twitches any part of the body; misrepresents facts to gain an end.

[4]This analysis was made some what separately from that in following age tables and includes, in addition to the 555 subjects already described (p.27), twenty-four 4½ year olds.

Children were rated in terms of how frequently the given behavior had been observed during the past month; "never", "less than once a week", "once a week", "several times a week", "daily or more". Each child's score was the average of three independent judgments made by teachers who were in daily contact with the child in the school.

Reliability of Ratings. Each teacher was asked to re-rate two of her children on the sixty items, a week after the first rating was made. The agreement between first and second ratings (based on an average of 104 judgments each) ranged from 73 to 96 per cent in the case of individual teachers. The median agreement was 85 per cent.

To test the reliability of sampling, the data were also analyzed in two separate groups, one with 335 cases, the other with 237. The rank order correlations obtained from ranking the behavior items, on the basis of these two sets of data, were .89 .02 and .92 .01.

Analysis of Data

In the analysis, the percentage of children showing a given characteristic was determined for each degree of frequency. Separate age charts were secured on the basis of 1) the percentage of children showing the behavior to "any" degree and 2) the percentage of children showing the behavior to a marked or "habitual" degree (interpreted as several times a week, daily or more).

The present age groupings were so made that the reader might throw the data together into the customary twelve months' divisions, if desired. The 3 year old (two years, six months to three years, six months) would thus be represented by the 2-1/2 and 3 year old data and the 4 year old by the 3-1/2 and 4 year old data.

Only the last half of the second year is represented. Sufficient children below 24 months of age were not enrolled in the schools to make a study of children between 1:6 and 2:0 possible. This does not noticeably lessen the value of the results so far as nursery school teachers are concerned, for most schools do not take children before 24 to 30 months of age.

A very detailed study has been made of all the "peaks" and rapid declines or rises noted in a given behavior trait at successive age levels. The statistical significance of such differences has also been determined. In the summarized report presented in the following pages, the figures for the most outstanding differences are presented.

BEHAVIOR OF ALL PRESCHOOL CHILDREN

Table I contains a list of the behavior studied and of the percentage of children who exhibited each type 1) to any and 2) to a marked degree.

Comments

Approximately half of the traits studied were observed to occur to some degree in the majority (50 to 83 per cent) of the children. Even in the rather select environment of the nursery school 20 per cent or more of the children showed habitual tendencies to

Ask unnecessary help
Leave tasks incomplete
Waste time at routine
Ignore requests
Stay awake long at nap
Dawdle
Wriggle a great deal when sitting
Resist at rest
Play with fingers

Laugh, squeal, jump around excessively
Slur or speak indistinctly

Those characteristics which were found to some degree in 50 per cent or more of the children and which were habitual in 10 per cent or more of the cases fit into the picture which most of us already have of the preschool child. Preschool children are necessarily dependent upon adults--hence such over-reactions as "asks unnecessary help", "looks for praise", "goes to adult with criticism of others", "seeks attention by showing off", and "stays near adult". They still have inadequate motor control and short attention spans--hence behavior as "leaves tasks incomplete", "wastes time at routines", "dawdles". Preschool children are recognizedly very active--hence "wriggles a great deal when sitting" and "laughs, squeals, jumps around excessively". They are recognizedly negativistic--hence "ignores requests", "refuses to comply", "hard to reason with". They are also self-centered--hence "refuses to share", "grabs", "bosses", "attacks others". Similarly most of the other traits in the first half of the table reflect recognized characteristics of childhood.

The behavior found in less than 50 per cent of the children at any time and in less than 10 per cent of the children as an habitual tendency (the last half of Table I) seems, in general, to be more heavily weighted with emotional adjustments than does that previously described. All of the fears, the majority of the nervous tendencies, and such behavior as jealousy and temper outbursts, for instance, fall into this class. It may be that emotional adjustments as a whole are more representative of individual needs than of a general developmental pattern.

Obviously the interpretations given above are matters for conjecture. What is development and what is not can be settled in no such abstract manner as this. Neither can the following analysis provide the answers. But by securing a more critically descriptive picture of the various age levels than we have had before, we should obtain a better basis for seeking and understanding developmental trends as well as behavior difficulties at the preschool level.

DETAILED ANALYSIS OF AGE DIFFERENCES IN BEHAVIOR AT THE NURSERY SCHOOL LEVEL

THE TWO YEAR OLD (2:0 to 2:6)

GENERAL TENDENCIES

Children of two exhibit many tendencies which, in the normal course of events, tend to decrease gradually and regularly throughout the preschool period (Tables II and III).[4]

Comments

These tendencies at two seem to be rooted largely in a lack of control. Lack of physical control is seen in "wets self" and "breaks toys". Lack of vocomotor control is seen in "slurs" and "lisps", and possibly in such accompanying difficulties as "hard to reason with", "whines and grumbles". Lack of emotional control is suggested by "cries easily". The presence of these inabilities may also make for the two year old's lack of social interests and his hesitancy in seeking new experiences--may in other words lead to such behavior as "avoids play with others", "shrinks from notice", "fears strange people", "refuses food", "desires to be fed".

[4]Traits typical of more than one age level are included in the table for that age at which they reach a more definite turning point (always the latter of the two levels; in this case Table III).

TABLE 2

BEHAVIOR MOST FREQUENT AT TWO
(2:0 to 2:5 inclusive)

Behavior[1]	Age Levels 2	2½	3	3½	4	Ages Compared	Critical Ratio	Chances in 100
Percentage Showing Behavior to Any Degree								
Avoids play with others	.81	.73	.52	.39	.30	2 & 4	5.42	100
Shrinks from notice	.74	.42	.44	.28	.34	2 & 2½	2.98	100
Refuses food	.73	.60	.65	.60	.57	2 & 2½	1.15	87
Wets self, day	.61	.57	.31	.17	.11	2 & 4	4.67	100
Sucks thumb	.46	.44	.41	.36	.34	2 & 4	1.01	84
Desires to be fed	.32	.28	.18	.10	.02	2 & 4	2.90	100
Cries easily[2]	.83	.74	.62	.67	.49	2 & 4	3.70	100
Lisps[2]	.59	.45	.40	.34	.37	2 & 3½	2.25	99
Percentage Showing Behavior to Marked Degree								
Avoids play with others	.26	.17	.15	.10	.06	2 & 4	2.10	98
Shrinks from notice	.17	.11	.07	.06	.07	2 & 3	1.38	92
Refuses food	.33	.22	.18	.15	.12	2 & 4	1.94	97
Wets self	.26	.11	.06	.01	.04	2 & 3½	2.69	100
Sucks thumb	.18	.14	.12	.09	.08	2 & 4	1.14	87
Desires to be fed	.09	.04	.04	.02	.01	2 & 4	1.27	89
Dawdles at meals[3]	.55	.40	.33	.36	.31	2 & 4	2.11	98
Plays with fingers[3]	.30	.28	.23	.19	.17	2 & 4	1.25	89
Picks nose[3]	.30	.17	.16	.11	.11	2 & 4	1.88	97
Breaks toys[3]	.14	.03	.01	.02	.02	2 & 2½	1.49	93
Fears loud noises[3]	.10	.02	.02	.02	.02	2 & 2½	1.25	89

[1]Traits in this and the following tables have been ranked so that these which are high in both any and marked groupings precede those which appear in only one grouping and (2) so that the higher frequencies, within the above limits, are given first place.

[2]As habitual occurrences, these traits are most frequent at 2½ years.

[3]As general occurrences, "dawdles", is unrelated to age; "nose-picking" and "play with fingers" tend to increase with age but present too irregular a pattern to be included among any age tables; "breaks toys" and "feers loud noises", are as frequent or more frequent at 2½ as at 2.

It is not improbable that some of this behavior at two - as "cries easily", "sucks thumb", "desires to be fed" - is more truly an infantile than a two year old pattern, and that it has persisted largely because of common environmental weaknesses. Both "desires to be fed" and "cries easily", for example, would no doubt disappear earlier if the child were expected to feed himself when able and if he didn't get what he wanted by crying.

HABITUAL REACTIONS (BEHAVIOR PROBLEMS)

In practice the types of behavior just discussed are considered a problem only when they occur very frequently or habitually. The present section is based upon such habitual occurrences.

Comments

On the whole the behavior most generally found in the 2 year old is also a more frequent problem at this level.[5] In other words, the discussion given above for behavior tendencies also holds for behavior difficulties. The additional behavior difficulties found in Table II for the 2 year old only serve to exemplify further the preceding points.

Lack of physical control would seem, for instance, to be at least a partial factor in the so-called dawdling of the 2 year old. Lack of social interests

[5]The two exceptions to this are "cries easily" and "lisps" which, while frequent at 2, are slightly more so at 2½.

TABLE 3

BEHAVIOR WHICH REACHES A PEAK OR TURNING POINT AT 3½
(2:6 to 2:11 inclusive)

Behavior[1]	Age Level 2	2½	3	3½	4	Ages Compared	Critical Ratio	Chances in 100
Percentage Showing Behavior to any Degree								
Ignores requests	.74	.84	.75	.74	.74	2½ & 3	1.55	93
						2½ & 2	0.95	83
Avoids activities involving risk	.56	.73	.67	.60	.58	2½ & 2	1.47	93
						2½ & 4	2.11	98
Grabs toys	.65	.72	.60	.52	.63	2½ & 3½	3.08	100
Refuses to share	.54	.72	.64	.61	.70	2½ & 2	1.49	93
						2½ & 3½	1.65	94
Refuses to comply	.61	.72	.69	.66	.64	2½ & 2	0.91	82
						2½ & 4	1.06	85
Hard to reason with	.65	.68	.54	.54	.52	2½ & 3	2.06	98
Slurs	.68	.67	.54	.45	.44	2½ & 3½	3.32	100
Stays close to adult	.43	.66	.55	.49	.51	2½ & 2	1.97	98
						2½ & 3½	2.66	100
Grumbles or whines	.61	.60	.50	.45	.51	2½ & 3½	2.16	98
Gives in too easily	.52	.60	.43	.57	.57	2½ & 2	0.67	74
						2½ & 3	2.46	99
Asks unnecessary help[2]	.65	.82	.74	.71	.68	2½ & 2	1.55	93
						2½ & 4	2.19	99
Fears high places[2]	.45	.59	.57	.45	.35	2½ & 2	1.16	87
						2½ & 4	3.24	100
Breaks toys[2]	.41	.42	.33	.23	.23	2½ & 3½	2.92	100
Fears loud noises[2]	.19	.28	.27	.23	.15	2½ & 2	0.89	82
						2½ & 4	2.06	98
Percentage Showing Behavior to Marked Degree								
Ignores requests	.22	.32	.25	.24	.18	2½ & 2	0.98	84
						2½ & 4	2.06	98
Avoids activities involving risk	.14	.29	.19	.14	.09	2½ & 2	1.67	96
						2½ & 4	3.34	100
Grabs toys	.13	.29	.15	.12	.12-	2½ & 2	1.76	96
						2½ & 3½	2.70	100
Refuses to share	.17	.19	.15	.11-	.09	2½ & 4	1.85	97
Refuses to comply	.13	.23	.16	.18	.17	2½ & 2	1.18	88
						2½ & 4	0.99	84
Hard to reason with	.22	.20	.13	.15	.14	2½ & 3	1.30	90
Slurs	.12	.40	.25	.19	.19	2½ & 2	3.11	100
						2½ & 3½	3.30	100
Stays close to adult	.04	.21	.08-	.10	.05	2½ & 2	2.70	100
						2½ & 4	3.08	100
Grumbles or whines	.09	.17-	.11	.08	.10	2½ & 2	1.01	84
						2½ & 3½	1.91	97
Gives in too easily	.00	.12	.09	.10	.06	2½ & 2	3.18	100
						2½ & 4	1.33	91
Wastes time at routines[3]	.09	.42	.38	.25	.23	2½ & 2	3.99	100
						2½ & 4	2.64	99
Cries easily[3]	.17	.22	.18	.13	.12	2½ & 2	0.54	71
						2½ & 4	1.73	96
Lisps[3]	.18	.22	.15	.17	.14	2½ & 2	0.37	64
						2½ & 4	1.35	91
Rushes into danger[3]	.04	.10	.05	.03	.07	2½ & 2	1.09	86
						2½ & 3½	1.89	97

[1]For order of traits see footnote 1, Table II.

[2]For habitual occurrence "asks help" was not included in the report (p.28)-"fears high places", "breaks toys", "fears loud noise", were most frequent at 3 and 2 respectively.

[3]For any occurrence "cries easily" and "lisps" were most frequent at 2 and "wastes time" and "rushes into danger" were unrelated to age.

would seem to underly "refuses to share" - (in Table III since it is equally outstanding at 2 and 2-1/2). "Picks nose" may also be a partial index of non-social interests since it is a socially unaccepted trait and would conceivably tend to decrease as the child becomes more interested in other people and in their opinions.

Such behavior as "picks nose" and "plays with fingers" may be in part an infantile carry-over of interest in self-manipulation. Fear of loud noises is a recognized tendency in infants and would seem to be another infantile carry-over. It, interestingly enough, disappears almost completely between the ages of 2 and 2-1/2.

Further Comments and Interpretations

If we had been able to secure subjects of a younger age we would undoubtedly have found that some of the behavior discussed above really reaches its peak in infancy, and that the 2 year level marks but one step in the gradual decrease of the behavior. Crying, wetting and the types of self-manipulation already noted seem to be examples at point.

Other forms of behavior discussed seem to be more specifically descriptive of the 2 year old's life. The 2 year old's inadequate motor and vocomotor control and his undeveloped social interests seem quite naturally to make for 1) occasional lapses in physical control, 2) speech inaccuracies and difficulties, 3) a paucity of social activities and interests, and 4) a general hesitancy in adventuring or accepting new experiences.

THE TWO AND A HALF YEAR OLD (2:6 to 3:0)

GENERAL TENDENCIES

Behavior most often observed at 2-1/2 is listed in Table III.

Comments

It is apparent that much of the behavior singled out for discussion at the 2-1/2 year level is present in a large percentage if not the majority of children at other ages. In other words a first hand observer would probably be unable to see age differences in these traits. The critical ratios, however, indicate that these types of behavior are more pronounced at 2-1/2 than at other age levels studied and hence suggest that they may have special significance at this period.

What at first may appear to be an heterogeneous assortment of traits--as "refusing to comply with adult requests", "ignoring requests", "asking unnecessary help", "grabbing toys", "giving in too easily", "refusing to share", becomes understandable if we realize that the child at 2-1/2 is in the early stages of active experimentation both with materials and with other individuals. He probably asks help, just as he refuses to cooperate, because he does not yet have the proper perspective on his own abilities or inabilities. He gives in, just as he grabs or refuses to share, because he does not know as yet what are the best ways of making social contacts. He avoids risk just as he rushes into danger[6] because he has had insufficient experience in the past to be able to judge what is and what is not harmful.

The negativism which has long been an accepted but somewhat isolated characteristic of the 2-1/2 and 3 year old would seem from the above facts to be but one aspect of this general experimentation. "Refuses to comply", "ig-

[6]See section on "habitual" behavior. These were no age differences in the proportion of children showing any tendencies to rush into danger.

nores requests", "refuses to share", are no more significant than "asking unnecessary help", or than some of the other types of more submissive behavior.

In addition to the above traits the 2-1/2 year old still displays many of the characteristics common to the 2 year old. He frequently "breaks toys", an indication that he still lacks adequate motor control and an adequate understanding of the care of materials. He still "slurs", "is hard to reason with" and "whines and grumbles". He also displays a tendency toward temper outbursts (Table IV). These facts suggest that the 2-1/2 year old still lacks accurate vocomotor control and that he has not yet learned to replace the emotional behavior of the infant with his newly developed ability to talk and hence to reason. Apparently development along these lines is not so great as to bring about obvious differences in 2 and 2-1/2 year olds.

HABITUAL BEHAVIOR

Comments

The various examples of active experimentation noted above are equally conspicuous in the list of behavior problems typical at 2-1/2. "Avoids risk" and "rushes into danger" occur side by side. So do "refuses to share", "grabs toys", and "gives in too easily". Other examples include "refuses to comply", "ignores requests" and "stays close to adults".

The difficulties associated with learning to talk are also conspicuous in the problems of the 2-1/2 as well as the 2 year old. At the risk of undue repetition it seems justifiable to raise the question as to whether adults adequately realize what a difficult adjustment language acquisition involves or how many phases of behavior it may effect.

Wasting of time at routines is a conspicuous problem at 2-1/2 (and also at 3). It was, in fact, the one problem about which teachers seemed most aware. It is natural that routine habits would be conspicuous at this level, for it is here that children are first expected to, and are most actively trying to help themselves. It is also probable, however, that we use a fallacious standard in judging this behavior. If we judge in terms of time, as most of us tend to do, we must remember that the child naturally takes longer to do a task alone than with assistance, such as he had at an earlier age.

Further Comments and Interpretation

The present section gives us a setting for the previously isolated but accepted fact that negativism is greatest in children between 2-1/2 and 3. The section has indicated that a number of contrasting forms of behavior--giving in too easily as well as refusing to comply or share, avoiding risk as well as rushing into danger - are prevalent at this age while the child is seeking, through active experimentation, to know what are the best ways of handling the situations that he must meet. Negativism is only one of these exploratory types of behavior. It has been in the limelight so much in the past that it has no doubt tended to obscure these other equally significant reactions.

The very multiplicity of reactions which the term negativism has been used to imply has also no doubt made for confusion. In most studies the term negativism has included all forms of behavior other than complying with the stated task. Thus crying, clinging to mother, or hanging one's head were considered as negativistic as a defiant "no"! or as hitting, kicking or throwing away the involved materials. It seems to the writer that much of the work on negativism has hampered more than furthered our understanding of child development through this failure to classify and treat separately withdrawing and aggressive type of reaction. The present data together with a forthcoming report on sex differences seem to give some justification for that belief.

THE THREE AND THREE AND A HALF YEAR OLD (3:0 to 3:11)

GENERAL TENDENCIES AND HABITUAL BEHAVIOR

It is well recognized that increments of growth or change become less with increasing age. Day by day studies are necessary to catch important changes in the newborn infant whereas monthly or yearly studies suffice in the case of the older individual. Perhaps this same principle is operating in the present set of data. At least, it seems more meaningful to consider the 3 and 3-1/2 year olds as a single group than to seek distinguishing characteristics between them.

From Table IV it is evident that there is a scarcity of behavior difficulties typical of children between 3 and 4. Changes in behavior are as significant during this period as are distinctive peaks. "Wriggles a great deal when sitting" and "Fears strange people", for instance, show their most marked change, a decrease, between 3 and 3-1/2. An examination of other tables in the present report also indicates that the period between 3 and 4 is an in-between stage during which behavior which was characteristic at 2 is continuing to decline or in which behavior which will be prominent at 4 is beginning to increase.

TABLE 4

BEHAVIOR REACHING TO PEAKS AND TURNING POINTS AT 3 AND 3½ YEARS OF AGE
(3:0 to 3:11 inclusive)

Behavior	Age Levels Studied 2	2½	3	3½	4	Ages Compared	Critical Ratio	Chances in 100
Percentage Showing Behavior to Any Degree								
Most rapid change between 3 & 3½								
Wriggles when sitting	.70	.74	.73	.62	.67	3 & 3½	2.20	99
Fears strange people	.80	.47	.48	.36	.28	3 & 3½	1.15	87
						3 & 4	1.88	97
Peaks at 3 or 3½								
Fears animals[1]	.22	.39	.42	.26	.29	3 & 2	2.04	98
Jealous	.21	.31	.28	.38	.35	3 & 3½	2.04	98
						3½ & 2	1.79	96
Has temper outbursts	.35	.43	.34	.45	.22	3 & 3½	2.21	99
						3½ & 4	4.20	100
Percentage Showing Behavior to Marked Degree								
Most rapid change between 3 & 3½								
Wriggles when sitting	.26	.28	.32	.21	.17	3 & 3½	2.34	99
Fears strange people	.05	.07	.10	.04	.03	3 & 3½	2.31	99
Fears high places[2]	.14	.15	.14	.07	.01	3 & 4	4.33	100
						3 & 3½	2.59	99
Peaks at 3 or 3½								
Laughs, Squeals, Jumps[2]	.13	.14	.26	.27	.22	3 & 2	1.68	96
						3½ & 4	0.96	83

[1] As habitual occurrences these traits were unrelated to age.

[2] As a general occurrence, "fears high places" is greatest at 2½ years, laughs, squeals, jumps is unrelated to age.

Comments and Interpretations

The above facts suggest that the period between 3 and 4 years of age may be one in which the child is becoming integrated. He has explored many contrasting forms of behavior in the preceding year. Perhaps now he is selecting certain of these modes of behavior to be built into a characteristic pattern of response.

There are other reasons than those already given to suggest that the above supposition is worth considering. For one, it should be remembered that the

child at 3 and 3-1/2 is relatively free from variety of new adjustments--such as learning to walk, learning to talk, learning to recognize and accept the necessary aspects of one's daily routine--which he is acquiring at a younger age. In one sense the 3 year old seems to have reached a level where he can pause for a "breathing spell". He is still actively learning in the sense that he is broadening and evaluating his experiences and that he is practising and improving his own ability and skills, but he is acquiring little knowledge or ability which is distinctive from the earlier or succeeding year. The specific types of behavior listed in Table IV also lend support to the suggestion that the child at 3 and 3-1/2 years of age may be going through a period of integration and of re-evaluation.

THE FOUR YEAR OLD (4:0 to 4:6)

GENERAL TENDENCIES AND HABITUAL BEHAVIOR

At 4 years of age a group of traits which has not been previously discussed stands out in sharp relief (Table V). Most of these traits have shown a regular and significant increase in occurrence between 2 and 4. While some of them--as "relates fanciful stories as real", "misrepresent facts"--were not observed in any 2 year old, all but three are found in the majority of 4 year old children.

Comments

Such tendencies as "looks for praise", "seeks attention by showing off", and "criticizes others", suggest that the child at 4 is aware not only of other people but also of other peoples' attitudes and opinions. Social influences have become increasingly important factors between 2 and 4.

The prevalence of "relates fanciful stories" and "misrepresents facts" also suggests that ideation has become an important factor in the 4 year old. Between 2 and 4 also the child has gained sufficient mastery of language so that the process of using words does not absorb his time. He is now experimenting with words and ideas just as he experimented with materials at an earlier level. Only as he experiments with ideas does the problem of distinguishing between the real and the unreal become apparent. During the time that the child is learning this distinction it is natural that many fanciful stories should result. If by chance these fanciful stories are believed and bring desirable results the child is likely to try purposely misrepresenting facts to gain an end.

It seems unnecessary, at this point, to discuss in any detail the other types of behavior most frequent in 4 year olds. These findings are presented in Table V. Most of them are supported by other investigations. The peaks in such nervous tendencies as "twitches", "bites nails", "holds body tense", for instance are in keeping with the findings of Olson[7] that nervous tendencies tend to increase during the preschool years. The peak in "bosses others" at 4, as well as the secondary peaks in "grabs toys" and "refuses to share" (see Table III) are in keeping with the growth of selfishness which Berne[8] found to increase with age.

In closing the above section it should again be noted that the discussion of certain types of behavior in any one age group in no way excludes them from other levels. Such behavior as "refuses food", "asks unnecessary help", "ignores requests", "avoids risk", "refuses to comply", "stays near adults",

[7]Olson, Willard C: The Measurement of Nervous Habits in Normal Children: Minneapolis, Minn., Univ. Minnesota Press, (1929) pp. XII, 97.

[8]Berne, Esther Van Cleave: An Experimental Investigation of Social Behavior Patterns in Young Children: Univ. Iowa Stud., Stud. In Child Welfare, 1930, 4, No. 3, pp. 93 (p. 86).

etc., while all more prevalent at an earlier level, are still very common at 4 years of age. In other words, the distinctions drawn between age levels represent differences in emphasis rather than differences in types of behavior found. They are of value only as they tend to give perspective to our work.

TABLE 5

BEHAVIOR MOST FREQUENT AT FOUR
(4:0 to 4:5 inclusive)

Behavior[1]	Age Level 2	2½	3	3½	4	Ages Compared	Critical Ratio	Chances in 100
Percentage Showing Behavior to Any Degree								
Criticizes others	.43	.58	.61	.71	.86	4 & 2	3.91	100
Awake long at nap	.57	.69	.72	.70	.85	4 & 2	2.40	99
Looks for praise	.43	.61	.68	.69	.80	4 & 2	3.32	100
Bosses others	.26	.41	.54	.61	.72	4 & 2	4.50	100
Seeks attention	.32	.53	.57	.68	.72	4 & 2	3.64	100
Awake during nap	.33	.35	.42	.50	.81	4 & 3½	5.60	100
Relates fanciful stories	.00	.23	.39	.39	.50	4 & 2	10.20	100
Misrepresents facts	.00	.16	.22	.25	.27	4 & 2	6.30	100
Twitches	.26	.24	.28	.26	.37	4 & 2	1.07	85
Stutters[2]	.18	.12	.18	.20	.25	4 & 2½	2.24	99
Bites Nails[2]	.21	.27	.27	.33	.41	4 & 2	2.00	98
Holds body tense[2]	.30	.35	.45	.44	.50	4 & 2	1.85	96
Percentage Showing Behavior to Marked Degree								
Criticizes others	.04	.06	.08	.16	.18	4 & 2	2.50	99
Awake long at nap	.24	.19	.31	.40	.49	4 & 2½	4.24	100
Looks for praise	.04	.14	.16	.21	.30	4 & 2	4.25	100
Bosses others	.00	.03	.09	.18	.27	4 & 2	6.20	100
Seeks Attention	.04	.12	.15	.21	.21	4 & 2	2.97	100
Awake during nap	.14	.09	.14	.15	.20	4 & 2½	2.00	98
Relates fanciful stories	.00	.02	.04	.06	.10	4 & 2	3.39	100
Misrepresents facts	.00	.02	.01	.03	.03	4 & 2	1.80	96
Twitches	.00	.04	.05	.02	.08	4 & 2	3.02	100

[1]For order see footnote 1, Table II.

[2]As habitual occurrences these traits are unrelated to age.

CONCLUSION

As ideas which we should at least consider in developing a perspective on preschool children the preceding data:

1. Have pointed up the lack of control and the consequent infantile, self-centered characteristics of the 2 year old.
2. Have indicated that a great deal of experimentation is occurring at the 2-1/2 year old level, and have suggested the place which negativism should hold in this entire scheme.
3. Have thrown the 3 and 3-1/2 year levels into relief as a period in which few distinctly new abilities or experiences are occurring but in which a process of integration and re-evaluation is quite possibly going on.
4. Have given emphasis to the strong rule which ideas and opinions are beginning to play in the life of the 4 year old.

TABLE 6

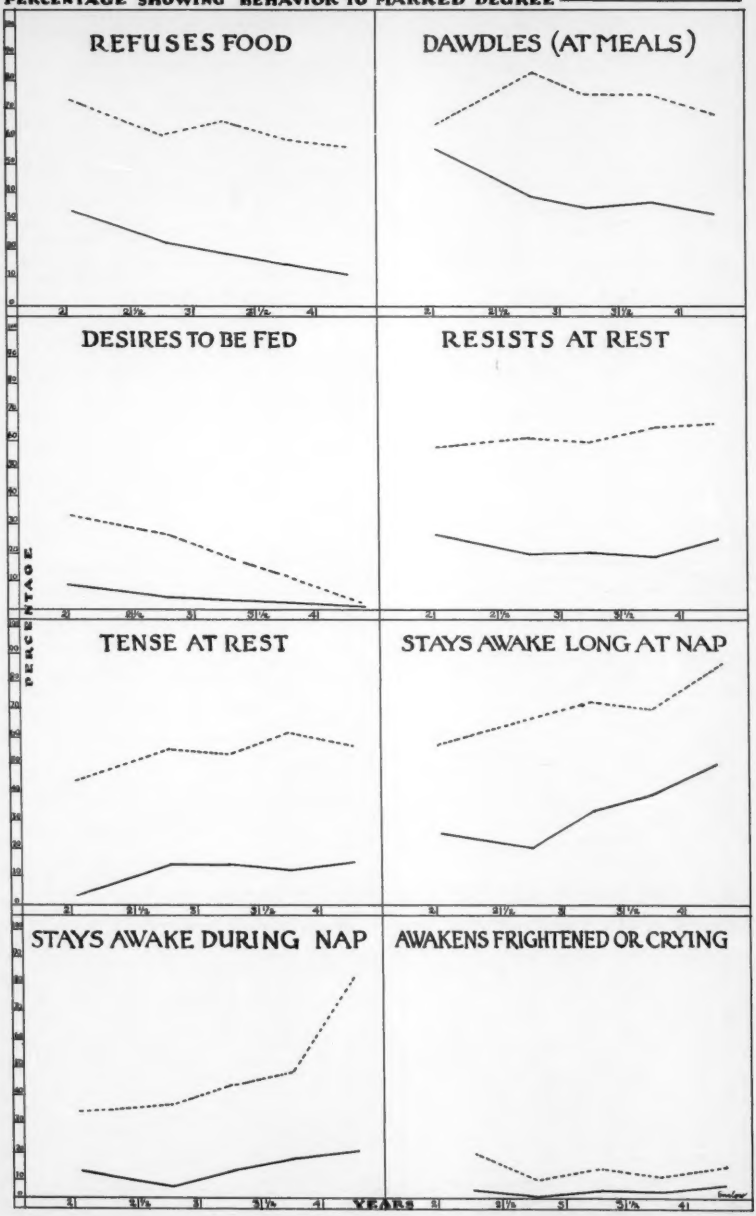
BASIC DATA: NUMBER OF CASES AND PERCENTAGE OF CASES SHOWING DEGREE OF BEHAVIOR

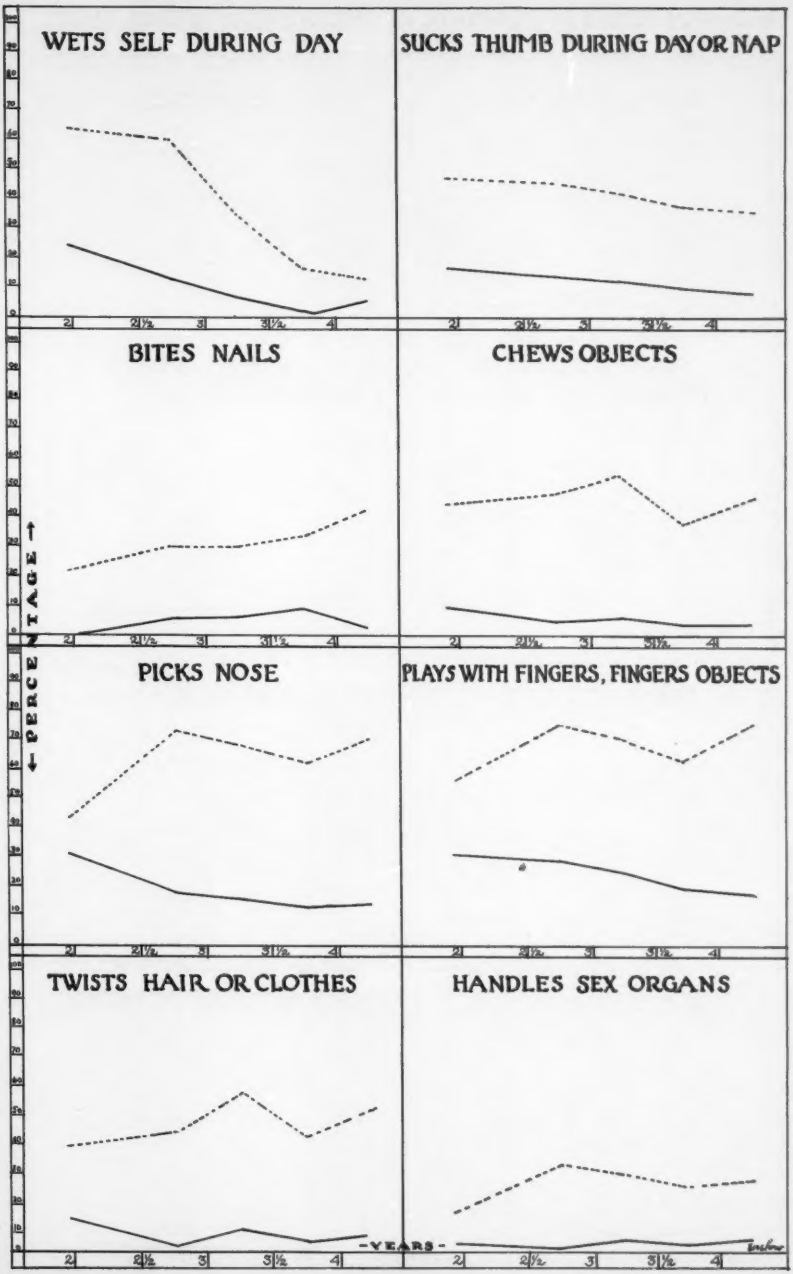
Ages:
2 yrs = 2:0-2:5
2½ yrs = 2:6-2:11
3 yrs = 3:0-3:5
3½ yrs = 3:6-3:11
4 yrs = 4:0-4:5

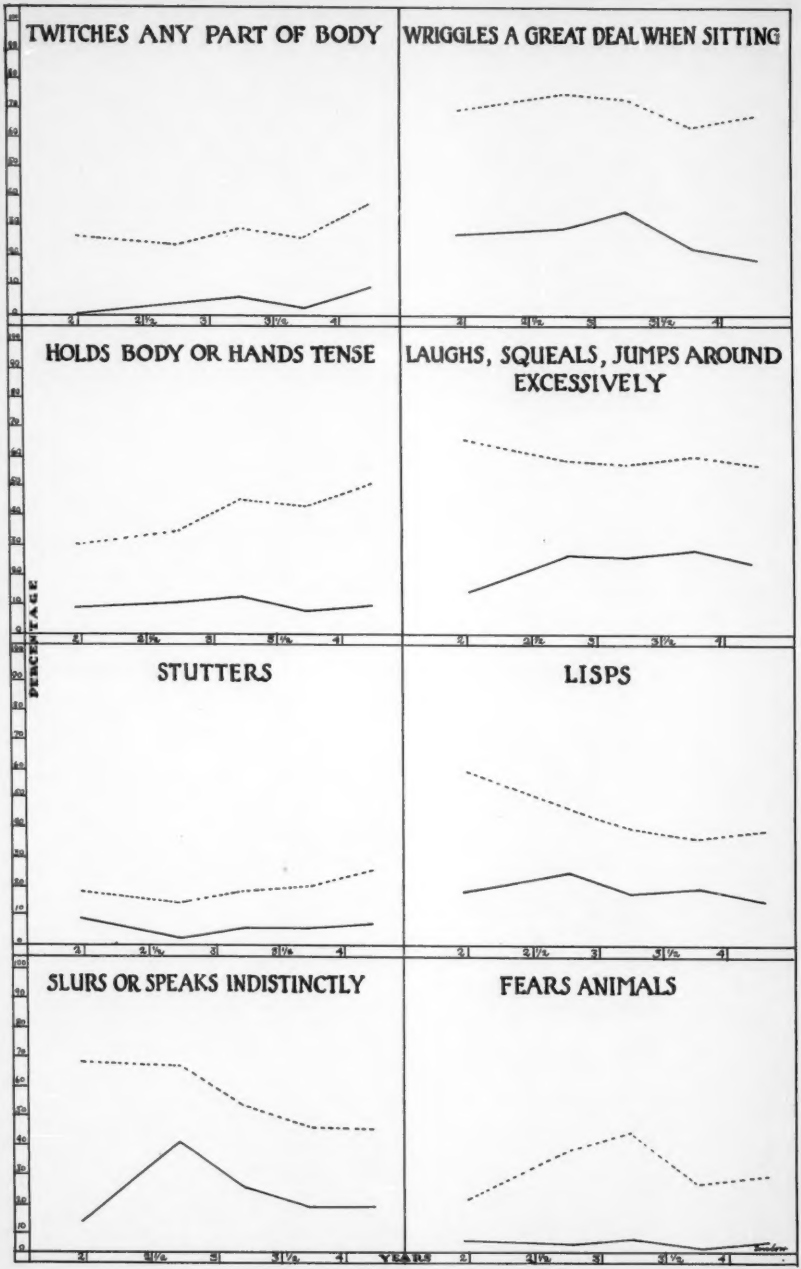
	Percentage of Cases										Number of Cases					
	To any degree					To marked degree										
	Age (years)					Age (years)					Age (years)					All
	2	2½	3	3½	4	2	2½	3	3½	4	2	2½	3	3½	4	Ages
Refuses food	75	60	65	60	57	33	22	18	15	12	21	71	147	175	92	506
Dawdles (at meals)	64	82	75	74	69	55	40	33	36	31	21	71	147	174	92	505
Desires to be fed	32	28	18	10	2	9	4	4	2	1	21	71	147	175	92	506
Resists at rest	57	62	60	64	65	26	21	21	20	26	23	74	162	188	101	548
Tense at rest	43	53	53	60	57	4	14	14	11	13	23	73	162	187	102	547
Stays awake long at nap	57	69	72	70	85	24	19	31	40	49	21	68	147	167	90	493
Stays awake during nap	33	35	42	50	81	14	9	14	15	20	21	68	146	168	90	493
Awakens frightened or crying	19	9	13	10	13	2	0	1	1	1	21	68	143	162	89	483
Wets self during day	61	57	31	17	11	26	11	6	1	4	23	74	162	189	104	552
Sucks thumb during day or nap	46	44	41	36	34	18	14	12	9	8	21	73	161	191	103	549
Bites nails	21	27	27	33	41	0	4	4	5	2	23	74	162	190	104	553
Chews objects	43	47	52	36	44	9	8	8	5	5	23	74	161	191	104	553
Picks nose	43	72	68	62	70	30	17	16	11	11	23	74	160	191	104	552
Plays with fingers, fingers objects	56	73	70	62	73	30	28	23	19	17	23	74	162	190	104	553
Twists hair or clothes	39	43	58	43	51	13	5	11	5	8	23	74	162	190	104	553
Handles sex organs	17	31	30	25	28	4	3	5	4	4	23	74	160	191	104	552
Twitches any part of body	26	24	28	26	37	0	4	5	2	8	23	74	161	191	104	553
Wriggles a great deal when sitting	70	74	73	62	67	26	28	32	21	17	23	74	161	190	104	552
Holds body or hands tense	30	35	45	44	50	9	10	11	6	9	23	74	162	191	104	554
Laughs, squeals, jumps around excessively	64	60	59	60	57	13	14	26	27	22	23	74	162	191	104	554
Stutters	18	12	18	20	25	9	1	5	5	6	22	73	152	189	104	540
Lisps	59	45	40	34	37	18	22	15	17	14	22	74	159	189	104	548
Slurs or speaks indistinctly	68	67	54	45	44	12	40	25	19	19	22	74	161	190	103	550
Fears animals	22	39	42	26	29	5	3	4	2	3	22	69	155	187	103	536
Fears strange people, objects and places	50	47	48	36	28	5	7	10	4	3	22	73	160	190	103	548
Fears loud noises	19	28	27	23	15	10	2	2	2	2	21	72	157	190	102	542
Fears high places	45	59	57	45	35	14	15	14	7	1	22	74	160	190	103	549
Refuses to comply	61	72	69	66	64	15	23	16	18	17	23	74	162	190	104	553
Ignores requests	74	84	75	74	74	22	32	25	24	18	23	74	162	189	104	552
Is hard to reason with	65	68	54	54	52	22	20	13	15	14	23	74	163	190	104	554
Seeks attention by calling or showing off	32	53	57	68	72	4	12	15	21	21	22	74	160	190	104	550
Asks unnecessary help	65	82	74	71	68	9	14	23	20	12	23	73	163	190	104	553
Looks for praise	43	61	68	69	80	4	14	16	21	30	23	74	163	191	104	555
Goes to adult with criticism of others	43	58	61	71	86	4	6	8	16	18	23	74	163	190	104	554
Stays close to adult	43	66	55	49	51	4	21	8	10	5	23	74	163	190	104	554
Shrinks from notice	74	42	44	28	34	17	11	7	6	7	23	74	163	190	104	554
Avoids play with others	81	73	52	39	30	26	17	15	10	6	23	73	163	191	104	554
Bosses others	26	41	54	61	72	0	3	9	18	27	23	73	163	190	104	553
Gives in too easily	52	60	43	57	57	0	12	9	10	6	23	74	163	191	104	555
Refuses to share or take turns	54	72	64	61	70	17	19	15	11	9	23	74	161	191	104	553
Grabs toys from other children	65	72	60	52	63	13	29	15	12	12	23	74	162	174	104	537
Attacks others (hits, kicks, bites, scratches, etc.)	61	54	46	55	55	22	11	9	11	14	23	74	163	191	104	555
Is jealous of others	21	31	28	38	35	4	2	4	3	3	23	74	163	191	104	555
Sulks ('is moodily silent, resists advances')	61	54	59	52	56	17	14	9	10	16	23	74	162	191	104	554
Grumbles or whines	61	60	50	45	51	9	17	11	8	10	23	74	162	191	104	554
Cries easily	83	74	62	67	49	17	22	18	13	12	23	74	162	190	104	553
Has temper outbursts (screams, kicks, strikes, throws self on floor)	35	43	34	45	22	9	3	3	2	5	23	74	152	191	104	544
Breaks toys, tears books, marks furniture	41	42	33	23	23	14	3	1	2	2	22	74	163	191	104	554
Mistreats animals	14	9	14	11	7	0	0	1	0	0	21	70	156	187	100	543
Wastes time at routine tasks	87	81	82	78	82	9	42	38	25	23	23	74	162	190	104	553
Leaves task incomplete	83	91	83	80	80	17	42	36	18	17	23	74	163	190	104	554
Daydreams	48	66	71	69	63	14	18	15	15	11	23	74	163	191	104	555
Relates fanciful stories as real	0	23	39	39	50	0	2	4	8	10	23	74	162	190	104	553
Misrepresents facts (purposely, to gain an end)	0	16	22	25	27	0	2	1	3	3	23	74	163	191	104	555
Secretly takes property of others	13	28	33	27	25	4	3	4	2	1	23	74	153	191	104	544
Rushes into danger	41	40	37	36	39	4	10	5	3	7	22	74	163	191	104	555
Avoids activities involving physical risk	56	73	67	60	58	14	29	19	14	9	23	74	163	191	104	555

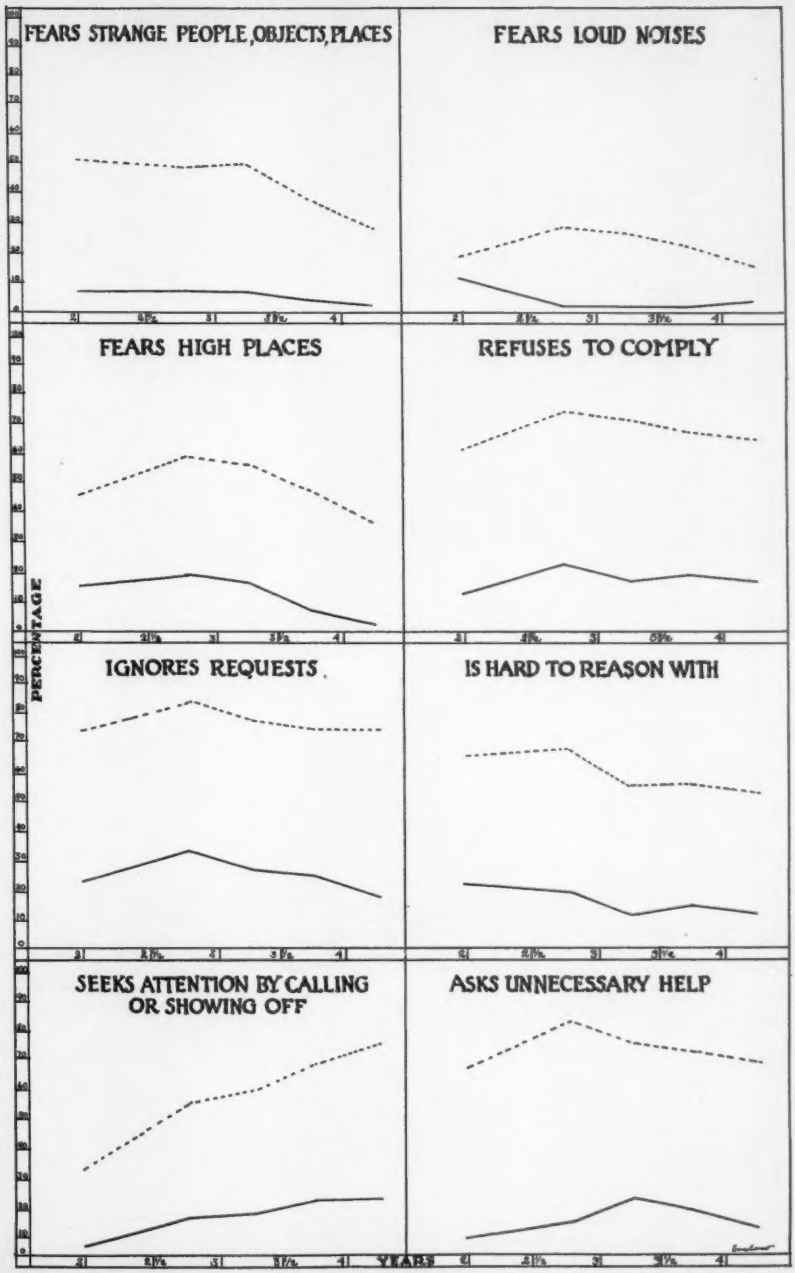
AGE DIFFERENCES IN BEHAVIOR AT THE NURSERY SCHOOL LEVEL

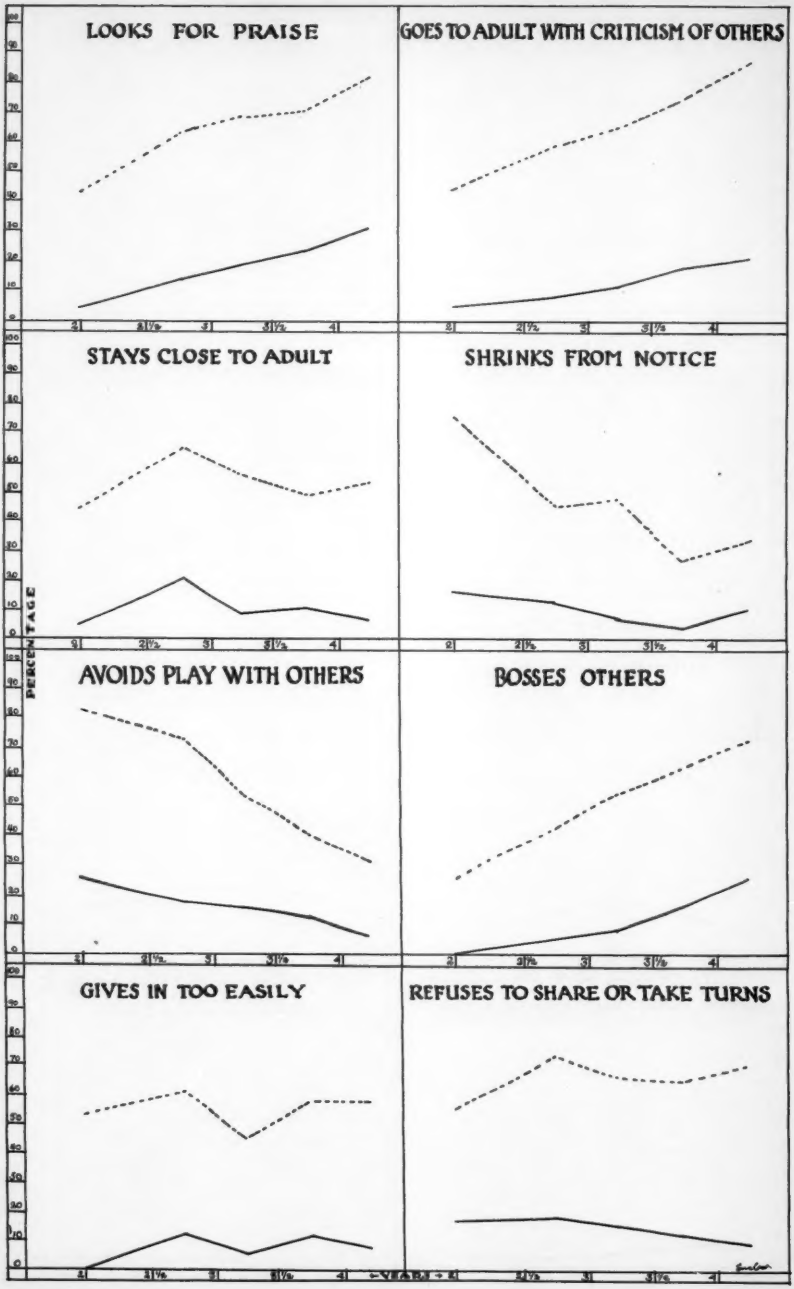
PERCENTAGE SHOWING BEHAVIOR TO ANY DEGREE .....
PERCENTAGE SHOWING BEHAVIOR TO MARKED DEGREE ——

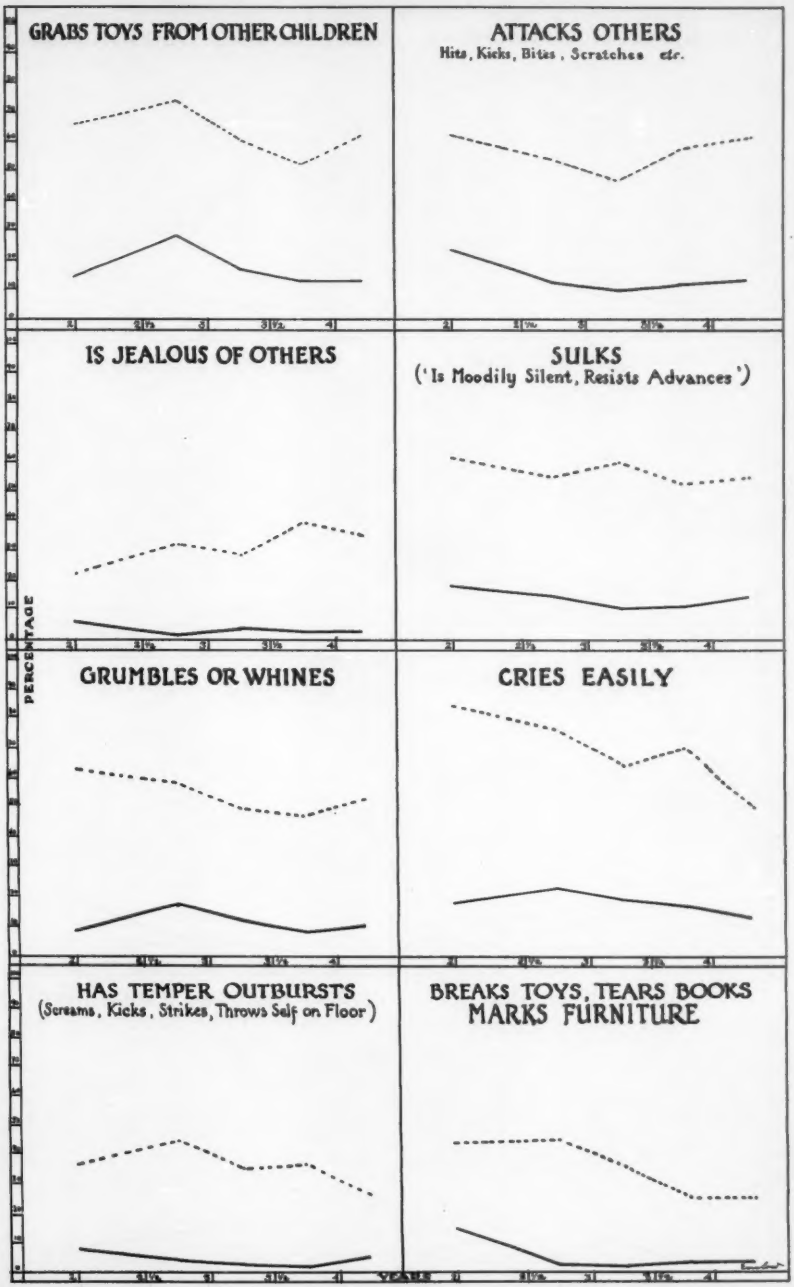


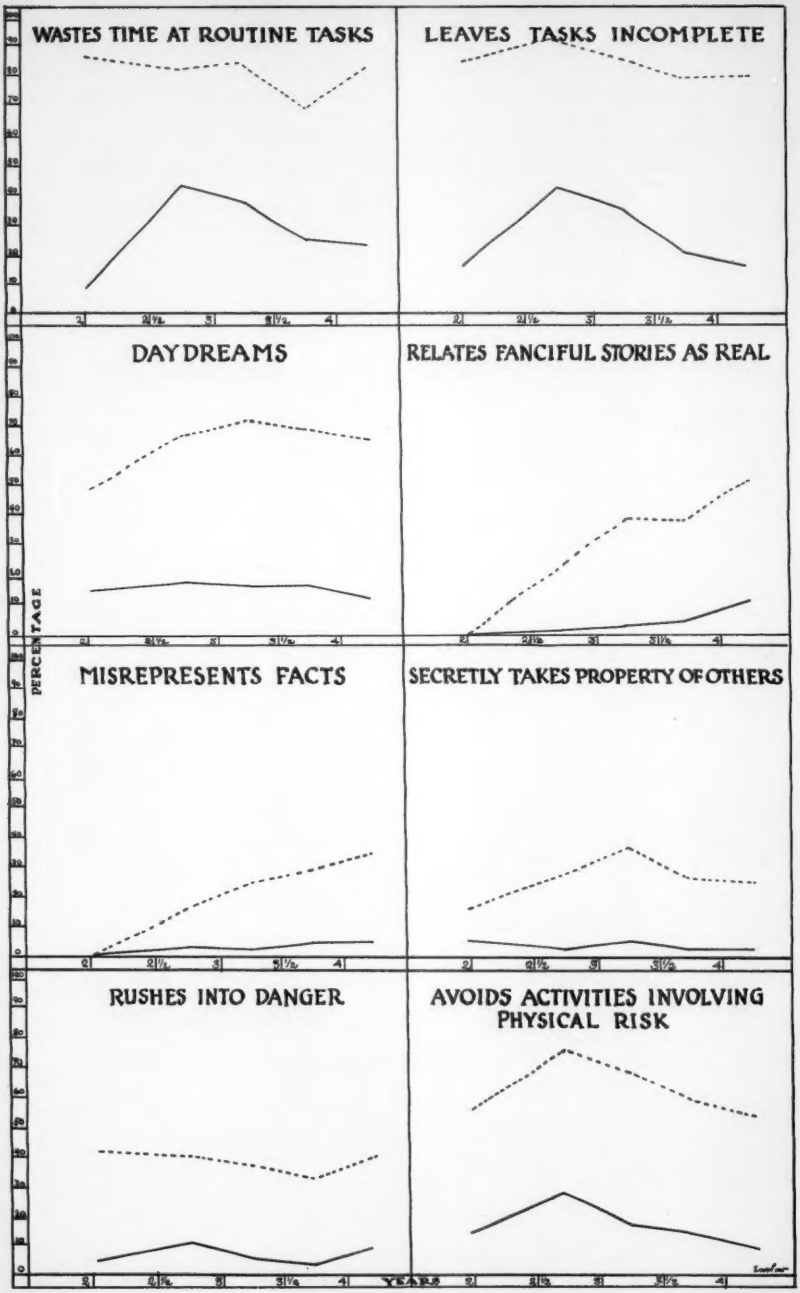

WETS SELF DURING DAY
SUCKS THUMB DURING DAY OR NAP
BITES NAILS
CHEWS OBJECTS
PICKS NOSE
PLAYS WITH FINGERS, FINGERS OBJECTS
TWISTS HAIR OR CLOTHES
HANDLES SEX ORGANS
PERCENTAGE
YEARS
2
2½
3
3½
4


TWITCHES ANY PART OF BODY
WRIGGLES A GREAT DEAL WHEN SITTING
HOLDS BODY OR HANDS TENSE
LAUGHS, SQUEALS, JUMPS AROUND EXCESSIVELY
STUTTERS
LISPS
SLURS OR SPEAKS INDISTINCTLY
FEARS ANIMALS
PERCENTAGE
YEARS
2
2½
3
3½
4


FEARS STRANGE PEOPLE, OBJECTS, PLACES
FEARS LOUD NOISES
FEARS HIGH PLACES
REFUSES TO COMPLY
IGNORES REQUESTS
IS HARD TO REASON WITH
SEEKS ATTENTION BY CALLING OR SHOWING OFF
ASKS UNNECESSARY HELP
PERCENTAGE
YEARS


LOOKS FOR PRAISE
GOES TO ADULT WITH CRITICISM OF OTHERS
STAYS CLOSE TO ADULT
SHRINKS FROM NOTICE
AVOIDS PLAY WITH OTHERS
BOSSES OTHERS
GIVES IN TOO EASILY
REFUSES TO SHARE OR TAKE TURNS
PERCENTAGE
2
2½
3
3½
4
←YEARS→


GRABS TOYS FROM OTHER CHILDREN
ATTACKS OTHERS
Hits, Kicks, Bites, Scratches etc.
IS JEALOUS OF OTHERS
SULKS
('Is Moodily Silent, Resists Advances')
GRUMBLES OR WHINES
CRIES EASILY
HAS TEMPER OUTBURSTS
(Screams, Kicks, Strikes, Throws Self on Floor)
BREAKS TOYS, TEARS BOOKS
MARKS FURNITURE
PERCENTAGE
YEARS


WASTES TIME AT ROUTINE TASKS
LEAVES TASKS INCOMPLETE
DAY DREAMS
RELATES FANCIFUL STORIES AS REAL
MISREPRESENTS FACTS
SECRETLY TAKES PROPERTY OF OTHERS
RUSHES INTO DANGER
AVOIDS ACTIVITIES INVOLVING PHYSICAL RISK
PERCENTAGE
YEARS
2
2½
3
3½
4

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CHANGES IN BODY PROPORTIONS DURING INFANCY AND THE PRESCHOOL YEARS: III. THE SKELIC INDEX

HOWARD V. MEREDITH AND VIRGINIA B. KNOTT[1]

As the title denotes, this is the third of a series of research papers dealing with changes in body proportions during infancy and the preschool years. The first paper (7) reported an investigation of the developmental course for the thoracic index during the postnatal period from three months to six years of age and gave a review of research literature on the trend of this index during prenatal life and between childhood and adulthood. The second paper (5) reported a study of the changing relation of width of hips to two major breadth measurements (shoulder breadth and breadth of thorax) and two major length measurements (stem length and length of lower extremities). Curves for each of the four indices, covering the first six years of postnatal life, were presented and discussed with reference to the so-called principle of "developmental direction."

PURPOSE

It is the purpose of this paper to report an investigation on the course of the skelic index. The report will include (1) an analysis of skelic index distributions for successive quarterly and semiannual age intervals between birth and six years of age, (2) an examination of the trend obtained for the index in terms of the growth patterns for each of its component measurements, (3) a review of the trend of the index during prenatal life, and (4) a supplementary analysis of skelic index distributions for annual age intervals covering the postnatal period from seven to eighteen years.

MEASUREMENTS USED IN CALCULATION OF THE INDEX VALUES

The skelic index is defined as:

$$\frac{\text{Length of lower extremities} \times 100}{\text{Stem length}}$$

In the present study, stem length was measured as vertex-rump length or sitting height, and length of the lower extremities was derived as stature minus stem length. On subjects under two years of age, stature was taken as vertex-sole length and stem as vertex-rump length. Both measurements were determined on the Baldwin Infant Measuring Board with the subjects in dorsal recumbency. Beyond two years of age stature was obtained in the erect standing position and stem as erect sitting height. The Baldwin Paper Measuring Scale and Square were used in taking both measurements, the head of the subject being oriented on the Frankfort Horizontal.[2]

DATA

The basic data consist of approximately 4,200 paired values for stature and stem length. These data were obtained from measurement of roughly

[1]From Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

[2]A more detailed discussion of the method of measuring stature and stem length employed at the Iowa Child Welfare Research Station has been published by one of the authors elsewhere (6, 125).

1,100 infants and preschool children of both sexes.

Aside from 100 pairs of observations made on newborn infants, the data were obtained from physical measurement records made at the University of Iowa infant laboratory, preschool laboratories, and elementary school. They represent observations accumulated on Iowa City children during the years 1929 to 1936 by the anthropometric staff of the Iowa Child Welfare Research Station. The children ranged in age between one month, fifteen days and six years, two months, thirty days. Many of them had repeated measurements over a period of two years or more. They were about equally divided as to sex.

In tabulating these data, each record was taken from the files in serial order. Those records were accepted for use that (1) fell between the age limits of one and one-half months and six years, three months, (2) carried paired values for stature and stem length, both taken either erect or recumbent, and (3) were not marked as applying to individuals of Negroid, Mongoloid, Jewish, or southwest European stock, or to individuals considered to lie outside the normal zone for physical build.

The 100 pairs of observations for newborn infants were gathered on fifty males and fifty females aged twenty-four to forty-eight postnatal hours. These neonatal values were obtained by Theodora H. Stebbins on full-term infants of American parentage born at the University Hospitals, Iowa City, during February and March, 1933.

Information on country of birth of the parents and grandparents and on the occupation of the father was available for approximately 50 per cent of the 1,100 subjects. Analysis of this material gave the following findings:

1. Both parents for more than 90 per cent of the subjects were born in the United States.
2. For around 55 per cent of the subjects, the parents and four grandparents were all born in the United States.
3. Roughly 30 per cent of the fathers were professional people and an additional 24 per cent were business proprietors, managers, or salesmen. Four per cent only were day laborers, while the remainder were about evenly divided between skilled trade employees, clerks and carriers, and university students.

The sample may be summarily characterized as being homogeneous with respect to geographic location, consisting of American-born children of northwest European ancestry, and representing a population heavily weighted with the professional and managerial classes.

In preparation of the basic data for analysis, it was first necessary to derive a figure for length of the lower extremities from each pair of values for stature and stem length. As already stated, the procedure employed was that of subtracting stem length from stature. Completion of this step gave upwards of 4,000 paired measurements for length of the lower extremities and stem length, and thereby permitted computation of 2,081 skelic index values for males and 2,100 skelic index values for females.

THE SKELIC INDEX DURING PRENATAL LIFE

Though the data of the present study do not extend into the embryonic or fetal periods, a brief review of the trend for the index during these periods constitutes a pertinent preface to our findings for the trend of the index in the early postnatal years.

The lower limb buds do not make their appearance until about the beginning of the fourth week of embryonic life. Consequently, the ratio of the length of the lower extremities to the length of body stem is zero prior to this age.

By the close of the second prenatal month the length of the lower extremities (derived as stature minus vertex-rump length) equals around 16 per cent of the length of the body stem (vertex-rump length). Figures and curves presented by Schultz (9) indicate that at 8-1/2 weeks menstrual age stature approximates 35.9 mm. and stem length 31 mm. These values yield 4.9 mm. as the length of the lower extremities and 15.8 per cent as an estimate of the skelic index.

The changing relation between the length of the lower extremities and the stem length during the fetal period (three to ten lunar months) has been studied by Schultz (9) and by Scammon and Calkins (8). Schultz finds lower limb length in percentage of stem length to be 32.4 at three lunar months, while Scammon and Calkins find it to be 36.9 at this age. At four, five, and six lunar months the findings for the two studies are almost identical. Means for stature and vertex-rump length obtained by Scammon and Calkins yield lower limb/stem ratios of 44.4 per cent at four months, 46.7 per cent at five months, and 47.7 per cent at six months. Corresponding ratios derived from charts for stature and vertex-rump length given by Schultz are 44.5 per cent at four months, 46.3 per cent at five months, and 47.8 per cent at six months.

Schultz finds the ratio of lower limb to stem to be the same at ten lunar months as at six lunar months. Specifically, his data give indices of 48 at six months, 49 at seven months, 47 at eight and nine months, and 48 at ten months. Scammon and Calkins' study, on the other hand, indicates a gradually rising index from six to ten lunar months. Ratios derived from their means for stature and vertex-rump length increase regularly from 48.3 at seven months to 49.3 at ten months.

Summary: Studies on embryos and fetuses indicate that the length of the lower extremities in percentage of the stem length is zero in the third prenatal week, roughly 35 at three lunar months, approximately 48 at six lunar months, and 48 or 49 at ten lunar months. These figures imply a rapid increase from the fourth week to the twelfth week, a decidedly less rapid increase between three and six lunar months, and little if any increase from six months to the termination of prenatal life.

THE SKELIC INDEX DURING INFANCY AND THE PRESCHOOL YEARS

The original data on the skelic index of infants and preschool children, as previously noted, consisted of 2,081 values for males and 2,100 values for females. These 4,181 indices were grouped into thirty-eight distributions, nineteen for each sex. In the case of each series, one distribution was made for the fifty neonatal indices; eleven distributions covered the successive quarterly intervals from one month, fifteen days to two years, ten months, fourteen days; and the remaining seven distributions extended over the consecutive semiannual intervals from two years, nine months to six years, two months, thirty days. This age allocation was followed so that the first distribution could be considered to fall "at birth" and so that the midpoints of the successive intervals would fall at even quarter-year ages up to three years and at regular half-year ages between three and six years.

Statistical constants obtained from analysis of the nineteen distributions in each series are given in Table 1. Figure 1 shows curves for the skelic index of males and females drawn to the two series of mean indices from Table 1. Inspection of the table and graph yields the following findings:

1. The mean skelic index at the beginning of postnatal life (24 to 48 hours following birth) is 51.7 for males and 51.4 for females. While the sex difference is slight, it is of interest to note that its direction is the same as

TABLE 1

SKELIC INDEX: LENGTH OF LOWER EXTREMITIES (DERIVED AS STATURE MINUS STEM LENGTH) IN PERCENTAGE OF STEM (VERTEX-RUMP) LENGTH

Mean Age Year	Mean Age Month	Cases	Mean	Standard Error of Mean	Standard Deviation	Range
			Males			
	0*	50	51.7	.46	3.22	44.5 to 59.5
	3	65	49.3	.46	3.75	41.6 to 57.5
	6	109	52.1	.35	3.67	43.0 to 62.0
	9	136	54.5	.26	3.09	47.0 to 61.5
1	0	152	57.1	.23	2.89	50.4 to 64.7
1	3	141	59.3	.22	2.67	51.8 to 65.1
1	6	118	61.0	.26	2.82	54.9 to 67.8
1	9	103	62.1	.25	2.56	55.4 to 67.7
2	0	109	63.9	.24	2.51	57.8 to 69.4
2	3	101	65.4	.24	2.39	59.6 to 70.6
2	6	94	67.2	.26	2.53	60.8 to 73.4
2	9	97	68.4	.26	2.59	62.1 to 75.2
3	0	119	69.7	.27	2.97	62.3 to 78.4
3	6	119	71.9	.27	2.90	64.1 to 80.1
4	0	113	74.1	.27	2.87	67.1 to 82.1
4	6	109	75.4	.27	2.78	69.0 to 82.6
5	0	114	78.2	.30	3.22	71.5 to 86.7
5	6	121	79.2	.25	2.77	71.7 to 87.1
6	0	111	80.9	.29	3.07	72.1 to 89.2
			Females			
	0*	50	51.4	.38	2.69	44.2 to 59.0
	3	51	49.5	.57	4.09	41.1 to 59.9
	6	106	52.9	.30	3.13	44.6 to 62.4
	9	116	55.4	.30	3.18	47.8 to 64.3
1	0	119	57.6	.27	2.95	50.9 to 65.8
1	3	108	60.1	.30	3.09	52.1 to 68.4
1	6	98	61.8	.30	3.02	56.1 to 69.4
1	9	87	63.8	.31	2.92	57.9 to 72.0
2	0	74	65.4	.32	2.75	59.6 to 73.5
2	3	74	66.9	.32	2.75	61.9 to 73.0
2	6	69	68.7	.31	2.58	63.8 to 76.2
2	9	74	70.1	.35	3.04	64.4 to 78.2
3	0	90	71.2	.30	2.80	64.9 to 78.3
3	6	133	72.9	.29	3.29	66.1 to 81.6
4	0	143	74.8	.27	3.27	68.1 to 83.0
4	6	146	76.4	.31	3.75	68.2 to 84.2
5	0	195	78.2	.25	3.56	69.6 to 87.0
5	6	185	79.4	.26	3.59	71.8 to 88.0
6	0	182	81.0	.26	3.48	71.3 to 90.1

*The statistical constants of this age are derived from data for fifty infants of each sex measured two days following birth.

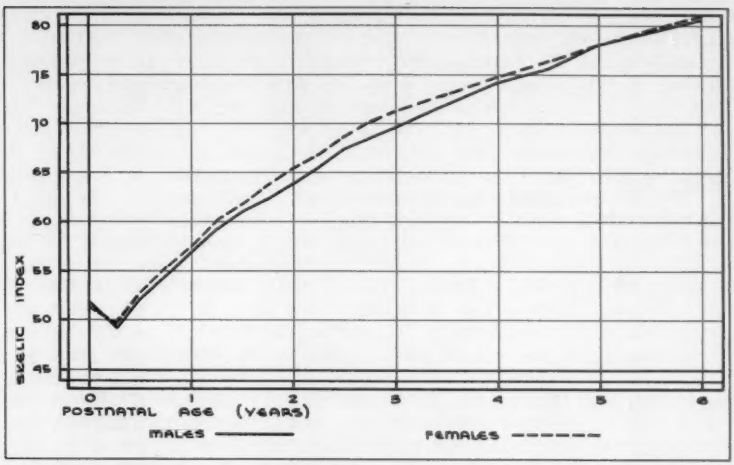

Figure 1. Skelic Index: Curves for the Age Period From Birth to Six Years Drawn to Mean Values From Table 1.

that obtained by Stockton-Hough (10). From an analysis of stature and stem length measurements made on 712 newborn, white infants, Stockton-Hough found the ratio of length of the lower extremities to stem length to approximate 53 for males and 52 for females. He concluded that female neonates have a longer stem in proportion to their lower limb length than do males.

2. For both sexes, there is a definite decrease in mean skelic index between birth and three months of age. Specifically, the index drops from 51.7 to 49.3 for males and from 51.4 to 49.5 for females. When aligned with research findings from other investigations, the validity of this decreasing trend appears open to question. On the one hand, Bayley and Davis (3) have reported means for stature and stem length (obtained from repeated measurement of thirty-one male infants and thirty female infants at monthly intervals between one month following birth and the end of the first year) which indicate that the skelic index decreases from approximately 54.0 at one month to 53.1 at three months in the case of males and from 53.1 at one month to 52.7 at four months in the case of females. On the other hand, there is not close agreement between the different studies as to the magnitude of the index at birth. Means for stature and stem length on newborn infants have been reported by Stockton-Hough (10), Taylor (11), and Bakwin and Bakwin (1). Estimates of skelic index at birth are roughly 53 for males and 52 for females (Stockton-Hough), 52 for males and 51 for females (the present study), 49 for males and 47.5 for females (Taylor), and 48 for each sex (Bakwin and Bakwin).

Further research is obviously needed to determine whether the skelic index decreases or remains constant during the first three months of postnatal life. It seems clear, however, that the length of the lower extremities does not increase in relation to stem length during this interval. On synthesizing the available findings for the early postnatal months and the findings for the fetal period, the probability is strongly suggested that additional research will establish the skelic index as remaining almost constant over the age span extending from the seventh lunar month of intra-uterine life to the third or fourth month of postnatal life.

3. There is a steady increase in mean skelic index from three months following birth to six years of age. The increase is from 49.3 to 80.9 for males and from 49.5 to 81.0 for females. Length of the lower extremities is thus equivalent to slightly less than one-half of stem length at three months of age and to somewhat more than 80 per cent of stem length by six years of age.

The rise in the index is greater between three months and three years than between three years and six years. For males, approximately 60 per cent of the rise from three months to six years takes place by three years of age. For females, the corresponding percentage is 69.

Bayley and Davis (3), Hejinian and Hatt (4), and Wallis (12) have reported findings for the stem-stature index over varying portions of the age intervals from three months to six years. Their means have been converted into values for the skelic index in order to obtain comparative material. Wallis' study gives skelic indices of roughly 58 at one year, 64 at two years, 74 at four years, and 80 at six years. These figures are all in close agreement with the figures of the present study. The values derived from Hejinian and Hatt are 64 at two years, 73 at four years, and 76 at five years, while those derived from Bayley and Davis rise from 53 at three months, through 56 at one year, to 66 at two years and 76 at three years. It will be noted that Bayley and Davis find less increase between three months and one year than if found in the present study. They write: "...the first year shows practically equal proportionate growth for the stem length and for the total length. It is only after the 12th month that the legs begin to grow rapidly ..."(12, p. 45).

4. At no age between three months and six years does the mean skelic index for males exceed that for females. On the contrary, the mean for females tends to surpass that for males throughout this period, while it is clearly and consistently higher than that for males from ages six months to four years, six months. It is thus found that at least between the latter half of the first postnatal year and the middle of the fifth year, the average female child has longer lower extremities relative to stem length than has the average male child. Wallis (12) obtained this same finding "between one and five years" and noted that the change to the relatively shorter stem length of the adult male must take place at a later age.

5. Variability in skelic index, as measured by the standard deviation, shows no consistent trend either toward increase or decrease during the first six years of postnatal life. There is a slight tendency, however, for variability to be greater in the first year and from four to six years than between the ages of one and four years. Sex differences in variability are not marked. On the whole, females show a tendency to be slightly more variable than males.

6. There is considerable overlapping of the distributions for any two successive age groups. This may be seen by reference to the "Range" column. The range for males at birth is from 44.5 to 59.5. The upper limit of this range is exceeded by roughly 4 per cent of the male cases at six months, 18 per cent of the male cases at one year, 65 per cent of the male cases at eighteen months, and 95 per cent of the male cases at two years. Thus the range of individual differences is such that there are children at two years of age whose skelic indices do not surpass those for other children at birth. Likewise, the proportionate relation between length of lower extremities and stem length is identical for a few children as young as two to two and one-half years and a few as old as six years.

GROWTH PATTERNS FOR THE COMPONENTS OF SKELIC INDEX

To further elucidate the trend of the skelic index during infancy and the preschool years, separate analyses were made for length of lower extremities and

for stem length. The results of these analyses are shown in Tables 2 and 3 and in Figure 2. Findings for length of lower extremities are:

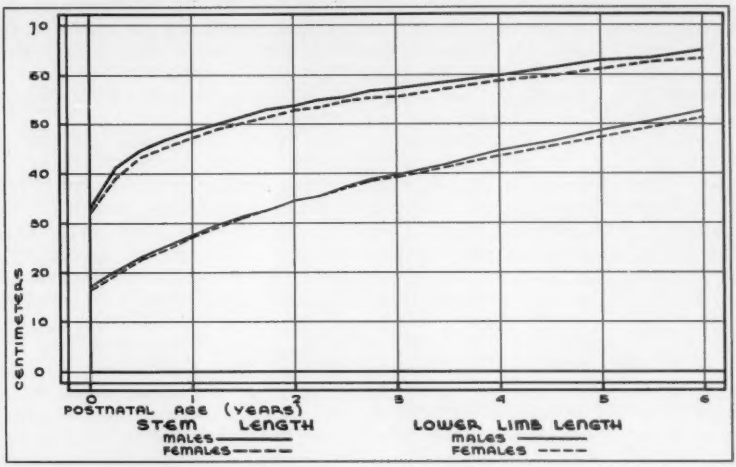

Figure 2. Stem Length and Lower Limb Length: Curves Drawn to Series of Means for Males and Females Given in Tables 2 and 3.

1. The mean length of the lower extremities for children six years of age is approximately three times as great as the corresponding mean for newborn infants. The exact values obtained are 17.1 cms. for males and 16.7 cms. for females at birth, and 52.5 cms. and 51.5 cms. for males and females respectively at six years of age.

2. The mean birth values for length of the lower extremities are doubled by two years of age for both males and females. Thus the absolute increase in lower limb length is as great during the first two postnatal years as during the succeeding four-year period.

3. In general the mean length of the lower extremities for males exceeds that for females over the first six years of postnatal life. At birth the difference approaches statistical significance, between eighteen months and four years of age it is negligible, while by six years it again approaches statistical significance.

4. The relative variability of lower limb length, as indicated by the coefficient of variation, is greater for the three-month distribution than for the distributions at any succeeding age. There is a slight tendency for the coefficient to decrease from six months and two years, six months and to show a mild increase between two years, six months and six years.

5. There is less overlapping of adjacent distributions for length of lower extremities than of adjacent distributions for stem length or for such dimensions as width and depth of the thorax (7). The lower limb length of every child studied at six months of age exceeded the maximum lower limb length obtained for newborn infants. The degree of overlapping of distributions, as one would expect, increases with age. This is illustrated by the fact that some six-year-old children were found to have lower limb lengths which did not exceed those of other children aged four years.

TABLE 2

LENGTH OF LOWER EXTREMITIES (CENTIMETERS): MEAN, STANDARD ERROR OF MEAN, STANDARD DEVIATION, COEFFICIENT OF VARIATION, AND RANGE VALUES FOR MALES AND FEMALES AGED BIRTH TO SIX YEARS

Mean Age		Cases	Mean	Standard Error of Mean	Standard Deviation	Coefficient of Variation	Range
Year	Month						
				Males			
	0*	50	17.10	.13	.90	5.3	15.4 to 19.1
	3	65	20.23	.21	1.72	8.5	16.3 to 23.9
	6	109	23.26	.15	1.60	6.9	19.8 to 27.0
	9	136	25.31	.12	1.38	5.5	22.2 to 28.2
1	0	152	27.68	.11	1.37	4.9	24.3 to 30.7
1	3	141	29.57	.11	1.26	4.3	27.0 to 32.7
1	6	118	31.38	.14	1.49	4.8	27.9 to 35.2
1	9	103	32.69	.14	1.45	4.4	29.6 to 35.8
2	0	109	34.35	.15	1.57	4.6	30.0 to 38.1
2	3	101	35.72	.15	1.53	4.3	31.5 to 39.2
2	6	94	37.26	.15	1.47	3.9	33.1 to 40.9
2	9	97	38.60	.17	1.71	4.4	34.6 to 42.9
3	0	119	39.78	.17	1.85	4.7	35.0 to 43.5
3	6	119	41.90	.18	1.94	4.6	37.0 to 45.9
4	0	113	44.32	.18	1.90	4.3	39.2 to 49.1
4	6	109	46.18	.19	1.98	4.3	42.0 to 52.2
5	0	114	48.69	.22	2.34	4.8	42.5 to 54.1
5	6	121	50.32	.21	2.35	4.7	43.5 to 55.9
6	0	111	52.50	.26	2.70	5.1	46.4 to 58.5
				Females			
	0*	50	16.67	.11	.81	4.9	14.5 to 18.4
	3	51	19.66	.22	1.60	8.1	16.3 to 23.7
	6	106	22.74	.13	1.33	5.8	18.8 to 25.7
	9	116	25.04	.13	1.42	5.7	21.3 to 29.1
1	0	119	27.23	.13	1.43	5.3	23.8 to 30.8
1	3	108	29.41	.14	1.51	5.1	25.8 to 33.6
1	6	98	31.13	.16	1.61	5.2	27.4 to 35.2
1	9	87	32.89	.18	1.69	5.1	29.2 to 37.6
2	0	74	34.44	.18	1.55	4.5	30.8 to 38.5
2	3	74	35.77	.20	1.69	4.7	31.5 to 39.6
2	6	69	37.23	.20	1.68	4.5	34.0 to 42.5
2	9	74	38.54	.21	1.81	4.7	34.7 to 42.7
3	0	90	39.73	.18	1.74	4.4	35.6 to 44.4
3	6	133	41.67	.18	2.08	5.0	37.7 to 46.9
4	0	143	43.93	.18	2.16	4.9	38.5 to 49.8
4	6	146	45.75	.19	2.35	5.1	39.6 to 51.9
5	0	195	47.79	.17	2.33	4.9	41.0 to 55.0
5	6	185	49.68	.19	2.52	5.1	43.3 to 56.9
6	0	182	51.47	.18	2.47	4.8	45.1 to 59.2

*The statistical constants at this age are derived from data for fifty infants of each sex measured two days following birth.

Stem length findings are:

1. The stem length means for males and females at six years of age are slightly less than twice as great as the stem length means for newborn infants. The specific values at birth are 33.1 cms. for males and 32.5 cms. for females. At six years the means are 64.9 cms. and 63.6 cms. for males and females, respectively.

2. Approximately fifty per cent of the increase for mean stem length during infancy and the preschool years occurs before eighteen months of age.

TABLE 3

STEM LENGTH (CENTIMETERS): MEAN, STANDARD ERROR OF MEAN, STANDARD DEVIATION, COEFFICIENT OF VARIATION, AND RANGE VALUES FOR MALES AND FEMALES AGED BIRTH TO SIX YEARS

Mean Age Year	Mean Age Month	Cases	Mean	Standard Error of Mean	Standard Deviation	Coefficient of Variation	Range
				Males			
	0*	50	33.12	.20	1.43	4.3	30.1 to 36.0
	3	65	41.05	.24	1.90	4.6	36.0 to 45.4
	6	109	44.64	.15	1.58	3.5	41.1 to 48.9
	9	136	46.51	.14	1.59	3.4	43.2 to 51.2
1	0	152	48.47	.14	1.75	3.6	43.6 to 52.8
1	3	141	49.97	.15	1.77	3.6	45.6 to 54.3
1	6	118	51.40	.17	1.90	3.7	47.7 to 57.6
1	9	103	52.70	.19	1.91	3.6	48.6 to 56.6
2	0	109	53.75	.17	1.81	3.4	50.0 to 58.2
2	3	101	54.64	.17	1.73	3.2	51.0 to 59.0
2	6	94	55.45	.20	1.96	3.5	51.1 to 60.2
2	9	97	56.42	.19	1.92	3.4	52.1 to 61.4
3	0	119	57.15	.19	2.05	3.6	52.7 to 62.3
3	6	119	58.29	.19	2.05	3.5	54.3 to 64.6
4	0	113	59.86	.20	2.08	3.5	55.6 to 65.8
4	6	109	61.27	.21	2.18	3.6	55.6 to 67.0
5	0	114	62.35	.22	2.31	3.7	56.3 to 68.6
5	6	121	63.57	.22	2.37	3.7	57.8 to 70.1
6	0	111	64.92	.23	2.47	3.8	58.1 to 71.8
				Females			
	0*	50	32.49	.16	1.10	3.4	30.1 to 35.3
	3	51	39.73	.29	2.04	5.1	35.3 to 44.0
	6	106	43.11	.17	1.74	4.0	38.6 to 47.7
	9	116	45.29	.16	1.73	3.8	40.4 to 49.6
1	0	119	47.31	.16	1.71	3.6	43.2 to 51.8
1	3	108	48.98	.15	1.59	3.2	45.3 to 53.0
1	6	98	50.38	.15	1.51	3.0	47.1 to 54.3
1	9	87	51.62	.17	1.61	3.1	48.1 to 55.5
2	0	74	52.71	.18	1.52	2.9	49.1 to 56.6
2	3	74	53.39	.18	1.54	2.9	49.5 to 57.3
2	6	69	54.21	.18	1.53	2.8	50.8 to 57.5
2	9	74	55.02	.22	1.90	3.5	51.1 to 59.0
3	0	90	55.81	.19	1.85	3.3	51.5 to 61.0
3	6	133	57.22	.19	2.24	3.9	51.9 to 62.9
4	0	143	58.65	.18	2.13	3.6	53.3 to 64.7
4	6	146	59.90	.18	2.16	3.6	55.0 to 66.0
5	0	195	61.10	.15	2.16	3.5	56.1 to 67.5
5	6	185	62.62	.16	2.17	3.5	56.9 to 68.7
6	0	182	63.61	.18	2.46	3.9	58.0 to 70.0

*The statistical constants at this age are derived from data for fifty infants of each sex measured two days following birth.

3. Throughout the entire age span from birth to six years, mean stem length for males is greater than that for females. In general the males surpass the females by a definitely larger margin than in the case of length of lower extremities. Except at birth, the differences consistently exceed one centimeter and are statistically significant.

4. The coefficient of variation shows the same general trend as for length of lower extremities. The highest coefficient occurs at three months and there is a slight tendency for the successive coefficients to decrease to two years, six

months and to increase thereafter. The magnitude of the coefficients, however, is of a distinctly lower order for stem length than for length of lower extremities.

5. Greater overlapping of distributions is found for stem length than for length of lower extremities after three months of age. However, comparing the "range" for newborn infants with that for infants between one and one-half and four and one-half months of age, it is seen that there is no overlapping of these groups.

Findings for lower limb length and stem length in relation to the skelic index are:

1. The decrease from birth to three months found for mean skelic index is explained by the large amount of gain in mean stem length over this interval. Whereas length of lower extremities increases only about 3 cms. between birth and three months, stem length shows gains of 7.9 cms. for males and 7.2 cms. for females. The greater increase in mean stem length for males also provides a counterpart to the finding that the skelic index of males falls below that of females at three months of age.

2. The general rise of the skelic index from three months to six years is corroborated by the fact that while stem length increases slightly less than 100 per cent during this time, length of lower extremities increases more than 200 per cent.

3. The means for stem length show wider sex differences (females shorter than males) than the means for lower limb length. Thus the higher skelic indices obtained for females are accounted for not by the fact of having longer lower limbs but by their shorter stem length.

THE SKELIC INDEX DURING CHILDHOOD AND ADOLESCENCE

The finding of a higher mean skelic index for females than for males, over the period from six months following birth to six years of age, suggested a continuation of the curves to discover the pattern followed in the conversion of this relation of the sexes to the reverse relation characteristic of adulthood. Consequently, a supplementary body of data was analyzed covering the age interval from six years, six months to eighteen years, six months.

The data consisted of stature and stem length measurements obtained at the University of Iowa elementary school and high school by the anthropometric staff of the Iowa Child Welfare Research Station. They were taken by the same anthropometric technique and represented the same type of racial, geographic, and socio-economic population as the data for the preschool years.

The method of deriving skelic index values was likewise strictly comparable to that employed with the data for the early postnatal years. Totals of 2,223 indices for males and 2,226 for females were computed. These indices were grouped into twelve distributions for each sex extending over the consecutive one-year age intervals from six years, six months to eighteen years, six months. The results obtained from analysis of the distributions are given in Table 4 and in Figure 3. Selected findings are:

1. For males, the mean skelic index rises from 82.9 at seven years to 94.6 at fourteen years and then declines to 90.8 at eighteen years. The mean index for females shows a rise from 83.6 at seven years to 92.0 at thirteen years, followed by a gradual fall to 87.7 at eighteen years.

2. The female index exceeds the male index until eleven years of age, but is exceeded by the male index between twelve and eighteen years. At nine years of age the mean index for females is 88.4 and that for males 87.4. At sixteen years the mean index for males is 93.3 and that for females 88.4.

3. The mean skelic index for both sexes increases during the age interval

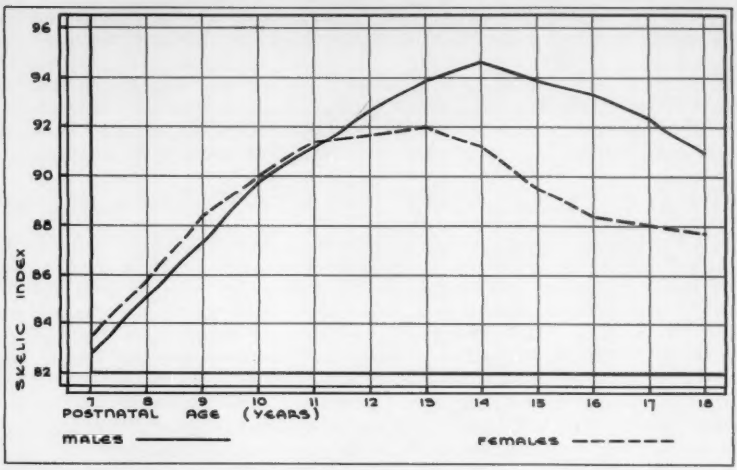

Figure 3. Skelic Index; Curves for the Age Period from Seven to Eighteen Years Drawn to Mean Values From Table 4.

from seven to twelve years and decreases during the period from fourteen to eighteen years. This implies that the lower extremities are lengthening in relation to stem length during childhood, while in late adolescence the stem is lengthening in relation to the lower extremities. Baldwin's (2) study of "gifted children" -- though limited to the age period from seven to fifteen years and based on a fairly small number of observations at each age -- is in general agreement. On conversion of the stem-stature indices reported to skelic indices, it shows a rise from seven to twelve years followed by a decline from twelve to fifteen years for females and a rise from seven to fourteen years followed by a fall from fourteen to fifteen years for males.

THE SKELIC INDEX FROM EMBRYONIC LIFE THROUGH ADOLESCENCE

Figure 4 gives a composite graph for mean skelic index over the age period from the end of the third prenatal week to eighteen postnatal years. This graph shows:

1. The skelic index rises from zero at four weeks of embryonic life, through 35 at three fetal months, to 48 at six months prenatal age.
2. The trend of the skelic index between six fetal months and three postnatal months is not conclusively determined. Certain of the available findings indicate that the index remains practically constant over this period, while certain other findings indicate a rise to around 52 at birth followed by a fall to about 49 at three postnatal months.
3. Between three months following birth and approximately thirteen and one-half years of age, the skelic index increases from 49 to 93.
4. A decline in the skelic index from 93 to around 89 occurs during the period from thirteen and one-half years to eighteen years.

TABLE 4

SKELIC INDEX: LENGTH OF LOWER EXTREMITIES (DERIVED AS STATURE MINUS STEM LENGTH) IN PERCENTAGE OF STEM (VERTEX-RUMP) LENGTH

Mean Age (Years)	Cases	Mean	Standard Error of Mean	Standard Deviation	Range
			Males		
7	207	82.90	.27	3.95	73.4 to 91.6
8	188	85.23	.25	3.49	75.2 to 95.0
9	180	87.42	.28	3.72	77.8 to 97.1
10	167	89.82	.31	3.98	79.7 to 101.4
11	165	91.15	.33	4.21	80.7 to 103.9
12	159	92.58	.35	4.38	81.9 to 103.8
13	171	93.94	.33	4.36	82.8 to 105.2
14	192	94.58	.33	4.63	84.7 to 105.9
15	211	93.92	.32	4.66	84.1 to 105.5
16	217	93.26	.30	4.48	82.2 to 103.9
17	193	92.30	.34	4.75	81.6 to 103.4
18	173	90.79	.33	4.30	81.5 to 101.5
			Females		
7	184	83.55	.26	3.56	74.8 to 93.2
8	190	85.91	.29	4.04	75.7 to 97.3
9	204	88.35	.30	4.28	76.8 to 100.4
10	212	89.95	.30	4.37	80.1 to 104.7
11	203	91.35	.32	4.54	80.4 to 105.1
12	203	91.70	.34	4.91	79.9 to 105.1
13	183	91.95	.38	5.14	79.5 to 104.2
14	184	91.16	.39	5.34	76.2 to 105.6
15	205	89.51	.33	4.74	77.0 to 105.0
16	183	88.44	.36	4.91	74.4 to 100.9
17	165	88.00	.38	4.85	74.5 to 100.2
18	110	87.70	.44	4.63	73.6 to 99.1

SUMMARY

The skelic index, defined as the percentage relation of length of lower extremities to stem length, is computed for approximately 4,200 paired measurements taken on upwards of one thousand children between birth and six years of age. Length of lower extremities is derived as stature minus stem (vertex-rump) length.

The indices are grouped into nineteen distributions for each sex and each distribution is analyzed for central tendency and variability. Findings for the index are presented in tabular, graphic, and descriptive form, and an attempt is made to elucidate these findings by examination of the growth patterns for the components of the index.

In addition to study of the skelic index and its component measurements during infancy and the preschool years, research findings on the proportionate relation between lower limb length and stem length during prenatal

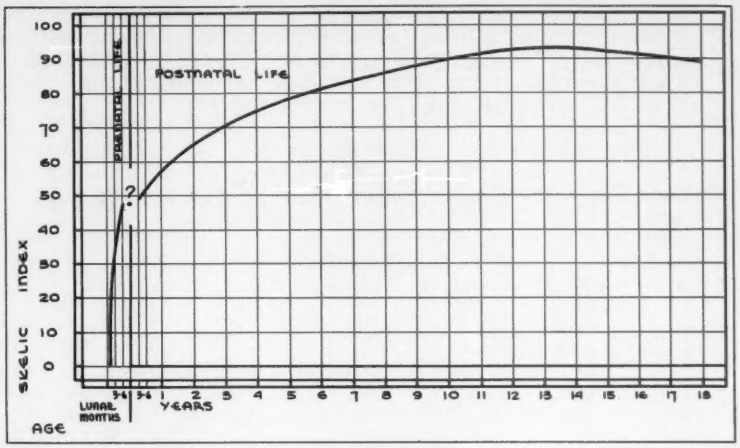

Figure 4. Skelic Index: Semischematic Curve Between One Lunar Month of Prenatal Life and the Eighteenth Postnatal Year.

life are reviewed and supplementary material is presented on the trend of the skelic index during the childhood and adolescent years from seven to eighteen.

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CONCEPTS OF CHILDREN AND COLLEGE STUDENTS EXPRESSED WITH 20 WORDS OF THE ACTION-AGENT TEST[1]

FRANK T. WILSON[2]

Forty-four five year old kindergarten children, 56 first grade children in the Horace Mann School, Teachers College, and 112 women students in the upper division of college were given the 20 action words shown in Table 1. The test was given to the children individually and their oral responses were written down by the examiner. The college students wrote their responses as the words were dictated to them in class groups.

ANALYSIS

The responses are shown in Table 1, word by word of the test, and in percentages for each group of subjects. Preceding each response in the table is the letter which refers to the category into which the response was placed for analysis according to the following classification:

a) correct and most common response
b) correct and generalized, broad or abstract response
c) correct and specific association, as a particular class of object or instance
d) correct and personal response
e) correct and childish expression
f) general and loose relationship, true in certain but not all respects
g) correct and of unusual or special meaning
h) incorrect response
i) phraseology

Exception may well be taken to some of the classifications made in the report. In explanation of the categories and the assignment of responses to them, the following arguments are given. First, the responses given most frequently by the college students were considered to be a) correct and most common. It seems logical to suppose that young adults would give the correct and most common responses to such common words as those of the test.

The category, f) general and loose, seemed necessary to provide for responses that in a way were correct, but upon careful consideration could not be called wholly correct. It was desirable to distinguish that sort of response from the category b) correct and generalized, broad or abstract. For example, the response "man" or "human beings", to What sleeps? is correct and generalized, while "everything" is general and loose, not strictly true. "People", "animals", "persons", "everybody" were classified general and loose, first because the strictly correct answer must be singular, and second, because the percentages were so much larger for the children than for the college students. As compared with these, the responses "man" and "human beings" (although the latter is plural instead of singular) are more abstract and generalized. It was felt that such differences in concepts, even if rather fine ones, should be brought out.

Another classification that may seem arbitrary was to put words made by adding "er" to the action word into the classification f) general and loose. For

[1]This report presents a minor phase of a study of Reading Readiness and Reading Progress in the Primary Grades of the Horace Mann School, Teachers College, New York, 1933-1937. This study has been made possible by the cooperation of Miss Agnes Burke, Teacher of Grade I, and other teachers of kindergarten and primary grades. It has been made under the supervision of Doctor Cecile White Flemming, Director of Pupil Individual Development and Guidance, and of Doctor Rollo G. Reynolds, Principal. Prepared with the assistance of the U.S. Works Progress Administration, New York City, project number 65-97-295, sub-project 25.

[2]From Hunter College, New York City.

TABLE 1

THE RESPONSES TO 20 ACTION WORDS MADE BY 129 COLLEGE STUDENTS, A, AND 100 CHILDREN, B, SHOWN IN PERCENTAGES, WITH THE CLASSIFICATIONS OF THE RESPONSES INDICATED BY LETTERS.*

1. stimulus word: sleeps

	A	B
a. baby, babies	29.8	46
b. child, children	16.1	8
f. people, animals, person, everybody	14.2	35
h. man	13.4	1
b. animal, a person	7.1	2
c. girls, boys	3.6	12
b. human beings	3.6	
c. cows, cat, dog	3.6	9
f. sleepers	3.6	
g. doll	1.8	
h. tired ones	.9	
b. living being	.9	
b. body	.9	
b. organic substance	.9	
d. us, ourselves, we you, I say		5
c. a lady, bird, horse, bear		4
d. mothers and fathers		1
f. everything		1
h. beds		1
no answer		5
	100.1	100

2. stimulus word: scratches

	A	B
a. cat, cats	61.6	43
c. nails, ewes, needles, sandpaper	9.8	2
c. dogs	8.9	6
c. chickens, chick, hens	7.1	9
c. mice, mouse, rat	2.7	2
h. bites	1.8	
g. elastic	1.8	
h. mosquito	.9	1
b. clos	.9	
b. mailed animals	.9	
c. fingers	.9	
c. tiger, lion, monkey, birds		
bear, cat-bird, male		8
c. kitties, pussy, pussy-cat		4
f. people, a person, children		3
f. animals		2
c. a knife, pens		2
c. kitten		1
d. I		1
g. carpenters		1
i. finger on desk		1
i. something to walk on		1
h. arms		1
unknown	2.7	
no answer		15
Total	100	100

3. stimulus word: flies

	A	B
a. birds	78.6	52
c. a fly, flies	10.7	19
c. bat, bats	4.5	3
c. airplane	2.7	2
c. mosquito	.9	
h. time	.9	
f. flier	.9	
h. liar	.9	
c. butterflies		14
c. bees		4
c. a bug		1
g. angels		1
i. black things with wings		1
c. bats		1
f. owl		1
no answer		1
	100.1	100

4. stimulus word: bites

	A	B
a. dogs	76.8	48
c. wolf, cats, bear, rat	6.2	10
c. teeth	3.6	
f. animals	2.7	6
c. mosquitos	2.7	6
c. insects	1.8	
c. fleas, bug	1.8	
f. children, man	1.8	
h. bees	.9	2
h. snake	.9	1
f. biter	.9	
c. lion, lions, tiger, tigers		13
c. spiders, turtles		2
f. people, everybody		2
d. we and the lions		1
c. your teeth		1
f. wild animals		1
no answer		2
	100.1	100

13. stimulus word: floats

	A	B
a. ivory soap, soap, ivory	30.2	1
a. wood, piece of wood, stick, board, log	17	22
c. cork	9.8	
f. person, people	7.1	4
c. water wings	5.4	
c. ice	5.4	
c. ships, steamer	3.6	3
c. raft, rowboats, sailboats, canoe, wooden boats	3.6	9
f. man	2.7	1
c. balloon	2.7	
c. duck	1.8	1
g. sponges	1.8	
c. bolsom	1.8	
g. ball	1.8	
c. boats	.9	28
c. buoy	.9	
g. apple	.9	
d. we	.9	
h. fin	.9	
g. paper		4
i. piece of paper, paper on water		3
h. fish		3
f. a boy, children		2
g. tin, rubber		2
c. dead fish		1
g. birds		1
i. piers in the water		1
i. light things on the water		1
c. pencils		1
c. bark		1
h. river		1
unknown	.9	
no answer		10
Total	100.1	100

14. stimulus word: growls

	A	B
a. dogs	96.7	11
c. lion	17.0	39
c. bears	17.0	20
c. wolf	6.2	3
f. animals	1.8	3
f. growler	.9	
c. tiger		9
h. owl		3
f. girl		1
i. wild animals		1
ah people		
unknown	.9	
no answer		10
Total	100	100

15. stimulus word: stings

	A	B
a. bees, bumble bees	90.0	84
c. mosquitos, wasp, fly	3.6	3
c. horse-fly	1.8	
g. insect bite	.9	
g. acid	.9	
f. butterfly		2
c. iodine		2
c. bumble bee		1
g. ants		1
h. mercurochrome		1
h. fire		1
g. poison		1
unknown	.9	
no answer		1
Total	100.1	100

16. stimulus word: gallops

	A	B
a. horse	98.2	87
c. pony		11
g. children		1
unknown	1.8	
no answer		1
Total	100	100

5. stimulus word: swims

	A	B
a. fish	85.7	31
f. a person, man, people	8.9	21
c. ducks	1.8	6
f. swimmer	1.8	
f. girl, children	.9	3
c. owl, sea-lion, frogs a turtle	.9	5
c. dog, horses		5
c. whale, elephant, hipos		7
d. I		1
i. somebody swims		1
i. everybody in the water		1
f. everything		1
no answer		3
Total	100	100

6. stimulus word: burns

	A	B
a. fire	82.1	64
c. wood, stick	8.9	12
c. coal	2.7	
c. dinner	1.8	
c. paper	.9	3
g. hot	.9	1
f. sun	.9	
f. burner	.9	
f. stoves, ovens		7
g. houses		3
g. food		2
g. car		1
h. smoke		1
g. scrape		1
unknown	.9	
no answer		2
Total	100	100

7. stimulus word: cuts

	A	B
a. knife, knives	82.1	53
c. scissors	12.4	19
c. razor	2.7	1
h. sharp blade	1.8	
f. cutter	.9	
c. saw, saws, axe, sword, lawn-mower		19
c. glass		2
f. man, men		2
h. food		1
i. when I fall on pavement		1
no answer		2
Total	99.9	100

8. stimulus word: blows

	A	B
a. wind	81.2	70
c. whistle	7.1	
c. horn	5.4	5
f. bubble	1.8	
f. balloon	.9	3
g. breath	.9	
g. gun	.9	
g. fire	.9	
g. paper	.9	
f. people		5
f. air		4
c. the mouth		2
f. a boy		1
i. babies a year old		1
i. paper when the window is open		1
h. lights		1
g. dynamite		1
f. pipes		1
no answer		5
Total	100	100

17. stimulus word: aches

	A	B
a. toothache, teeth	34.8	2
a. a pain	26.7	8
c. head	17.4	5
c. back, leg, feet, finger, hand	8.0	1
b. muscles, bones	4.5	
b. body regions, body	2.7	
g. sore, sore finger, wound	2.7	
a. stomach	1.8	13
c. tummy, belly		5
g. people		3
i. people if it hurts them		1
i. when you get hurt		1
unknown	.9	
no answer		61
	100	100

18. stimulus word: explodes

	A	B
a. dynamite	49.1	19
a. gunpowder, powder	16.1	4
c. bombs	8.9	8
c. gasoline, gas, gases, gas engine	8.0	6
g. cannons, gunfire, gun	4.5	6
c. TNT	3.6	
g. balloon	3.6	3
g. furnace	1.8	
f. steam	1.8	
g. stove	.9	
c. bubble	.9	
c. fireworks	.9	
h. fire		6
g. cigar fire cracker		3
g. chemical set, tires		
g. volcanoes		3
g. bullet		2
g. house, houses		2
g. gas tank, engine		2
i. things that get on fire		1
i. fire in a car		1
i. food it burns		1
h. water		1
i. my daddy's office		1
no answer		17
	100.1	100

19. stimulus word: roars

	A	B
a. lion	83.0	46
c. tiger, tigers	3.6	13
f. animals, big animals	3.6	2
c. ocean, Niagara Falls, waves, sea-waves	2.7	6
g. fire, furnace	2.7	
g. crowd, angry people, fascar	2.7	
c. cannon	1.8	
c. wind, thunder, storms		6
c. bear, bears, wolves		4
h. whistles, boat		2
no answer		21
	100.1	100

20. stimulus word: runs

	A	B
a. cat	87.5	62
h. cow	4.5	4
c. kittens	3.6	10
g. persons, child	3.6	
h. pussy	.9	1
a. pussy-cat		3
a. kittie		2
h. mules		1
no answer		17
	100.1	100

9. stimulus word: shoots

	A	B
a. gun	91.0	66
c. cannons	2.7	3
c. pistols	2.7	
c. firecracker	.9	
h. arms	.9	
g. star	.9	
f. gunner	.9	
c. arrows		2
f. man		2
g. roller-coasters		1
h. horn		1
g. fire		1
f. people		1
c. machine gun		1
no answer		2
Total	100	100

10. stimulus word: melts

	A	B
a. ice	62.5	36
c. butter	19.7	23
c. snow	8.0	15
c. ice-cream	5.4	17
c. wax	1.8	2
h. heat	.9	
c. iron	.9	
f. metal		1
f. everything		1
c. sugar		1
i. fire melts iron pipes		1
unknown	.9	
no answer		3
Total	100.1	100

11. stimulus word: sails

	A	B
boat	65.2	68
ship	27.7	9
sail-boat	5.4	18
canoe	.9	
sailor	.9	
kite		2
no answer		3
Total	100.1	100

12. stimulus word: boils

	A	B
a. water	55.5	23
b. liquid	1.8	
f. fire	1.8	
f. boiler	.9	
c. eggs, potatoes, soup, meat, milk, cereal, beets carrots, chicken, fish		29
c. food		15
c. pot, kettle, tea-kettle, pans, cooking things		11
c. hot water, tea		4
i. things to eat, everything I eat		3
f. stove		3
i. all kinds of vegetables		1
i. things on the stove		1
i. things I cook		1
i. pot in hot water		1
h. steam		1
no answer		11
Total	100	100

*See page 63 for list of classifications by letter.

example a "sleeper sleeps", a "flyer flies", etc. Such responses could scarcely be called b) generalized, broad or abstract concepts. Nor did they seem to belong in the category c) correct and specific. For example, "sleeper", as a response to What sleeps?, should be distinguished from such concepts as "horse", "bird", etc.

The category, g) correct and of unusual or special meaning, seemed worth while distinguishing from c) correct and specific. For example, some "dolls", but not all, sleep: an "elastic" or "carpenters" may scratch, but such associations are of unusual instances.

The remaining classifications seem obviously proper and show, perhaps, points of interest in the comparison between the two groups.

FINDINGS

Table 1 shows the percentages of responses each group of subjects made according to groupings of their replies. All important details, it is believed, are shown in this table.

Table 2 summarizes Table 1 and brings out the main differences between the groups, according to the categories. The percentages of students and children giving responses to each word are shown according to each classification. At the bottom of each subdivision of the table is given the average percentages.

The greatest difference between the groups was in the proportion of correct and most common responses given. The college students gave on the average 75.16 per cent of such responses, as compared with 48.4 per cent by the children. The students gave higher percentages of these responses than the children in all but one instance. This was for the word sails, for which 68 per cent of the children gave "boat" as compared with 65.2 per cent of the college students. The word which produced the greatest difference was boils. Ninety-five and five-tenths per cent of the college students gave "water"; 23 per cent of the children. The ranges of this category of responses were 45.6 per cent to 98.2 per cent for the college students, and 11 per cent to 87 per cent for the children. This indicates considerably more varied responses for the children.

This greater variation of response by the children is indicated especially by category c) correct and specific. The children averaged 27.65 per cent of responses of this type, the students 16.5 per cent. The ranges were 1 per cent to 71 per cent and 0 per cent to 40.2 per cent respectively. Inspection of Table 1 shows particulars wherein the variations were found. First, the children tended to name more frequently than the students those agents given by both. For example, in response to What sleeps? 3.6 per cent of the students gave "girls" or "boys", and 12 per cent of the children; "cows", "cat", "dog" were given by 3.6 per cent of the students, by 9 per cent of the children. Second, the children tended to give other of these specific type of responses more frequently than the students. For example, to What sleeps? the students named no other specific responses not named by the children, but the children added the responses "a lady", "bird", "horse", "bear". For the word boils the students named no specific objects other than water, while the children named 10 varieties of food, 5 varieties of cooking utensils, 15 per cent said "food" and 4 per cent "tea" or "hot water."

Another considerable difference between the groups was in the omissions and incorrect responses made. Every college student responded to all the words, but there was an average of 10.9 per cent of no answers to the entire 20 words by the 100 children. The college students made an average of .59 per cent incorrect answers, the children, 1.8 per cent.

Phraseologies gave averages of 1.45 per cent and 0 per cent, respectively, for children and students; personal responses, .45 per cent and .05 per cent;

TABLE 2

PERCENTAGES OF RESPONSES ACCORDING TO CATEGORIES

Stimulus Word	a Most common	b Generalized	c Specific	d Personal	e Childish	f Loose	g Unusual	h Incorrect	i Phraseology	Unknown	Total
	Responses College Students										
sleeps	45.6	27.7	7.2			17.8	1.8				100.1
scratches	61.6	1.8	29.4				1.8	2.7		2.7	100
flies	78.6	.9	18.8			.9		.9			100.1
bites	76.8		16.1			5.4		1.8			100.1
swims	85.7		2.7			11.6					100
burns	82.1		12.5			.9	3.6			.9	100
cuts	82.1	1.8	15.1			.9					99.9
blows	81.2		13.4			3.6	1.8				100
shoots	91.0	.9	6.3			.9	.9				100
melts	62.5	.9	35.8							.9	100.1
sails	65.2		33.1			.9		.9			100.1
boils	95.5	1.8				2.7					100
floats	47.2		35.9	.9		9.8	4.5	.9		.9	100.1
growls	56.2		40.2			2.7				.9	100
stings	92.0		5.4				1.8			.9	100.1
gallops	98.2									1.8	100
aches	81.2	7.2	8.0				2.7			.9	100
explodes	49.1		38.4			1.8	10.8				100.1
roars	83.0		8.1			3.6	5.4				100.1
mews	87.5		3.6		.9		3.6	4.5			100.1
Average	75.16	2.15	16.50	0.5	0.5	3.18	1.94	0.59	0	0.50	100
	Children										
sleeps	24	3	25	6		36		1		5	100
scratches	40		30	1	4	5	1	2	2	15	100
flies	52		44		1		1		1	1	100
bites	48		34	1		9		3		5	100
swims	50		19	1		25			2	3	100
burns	64		16			7	9	1	1	2	100
cuts	53		41			2		1	1	2	100
blows	70		7			14	1	1	2	5	100
shoots	86		6			3	2	1		2	100
melts	36		58			2			1	3	100
sails	68		29							3	100
boils	23		55			3		1	7	11	100
floats	23		44			7	7	4	5	10	100
growls	11		71			4		3	1	10	100
stings	84		5		1		2	4		4	100
gallops	87		11				1			1	100
aches	28		1		5		3		2	61	100
explodes	13		18				21	7	4	37	100
roars	46		29			2		2		21	100
mews	62		10		6			5		17	100
Average	48.4	0.15	27.65	0.45	0.85	5.95	2.4	1.8	1.45	10.9	100

childish terms .85 per cent and .05 per cent. Examples of phrases given by the children were: "finger on desk", "something to walk on", scratch; "black things with wings" fly; "everybody in the water" swims, etc. The only personal response by college students was "me" to the question What floats? Some of the children's personal responses were: "we", "I may", "we do", "ourselves", etc. Childish terms were such as "pussy-cat", "bungle-bee", "butt", etc. It is interesting to note that the children used very few of these

kinds of responses. It seems somewhat surprising that only two college responses were of these three kinds.

The students gave an average of 2.15 per cent generalized concepts, the children .15 per cent. Most of the action words precluded the probability of a generalized concept as defined in the classification used. This kind of response was given by the students to only 8 of the 20 words. The only one on which the children made such a response was sleeps. One child answered "man", another "animal", and a third "a person". In contrast 27.7 per cent of the students gave a general concept in response to this word. The difference on this response is probably more representative of the two groups than that of the test as a whole.

The concepts classified as "general and loose" showed averages of 5.95 per cent for the children and 3.18 per cent for the students.

The remaining category, g, unusual or special in meaning, shows about the same averages for each group, 1.94 per cent for the college students, 2.40 per cent for the children. For both groups this type of response shows particular experiences wherein, presumably, the associations were made. On the whole the associations of the college students suggest mature as compared with childish experiences. For example, the students gave such replies as "dinner", "heat", "sun" burn; "breath" and "fire" blow; "star" shoots; "sponge", "ball", "apple" float; etc. The children replied "carpenters" scratch; "angels" fly; "houses", "car", "potato", "scraps" burn; "roller coasters", "fire" shoot; etc.

SUMMARY

On a test of 20 action-agent words 1) as compared with college students children of kindergarten and grade one showed: a) a lesser percentage of most common and of generalized concepts; b) a greater variety of specific concept responses; c) a greater percentage of personal, general and loose, and incorrect concepts; d) a greater percentage of childish terms and phrases; e) about the same percentage of unusual or special meanings, which, however, tended to be indicative of child rather than adult experiences. 2) College students showed an appreciable percentage of general and loose, and of incorrect responses to these familiar words.

STUDIES IN FETAL BEHAVIOR: II. ACTIVITY OF THE HUMAN FETUS IN UTERO AND ITS RELATION TO OTHER PRENATAL CONDITIONS, PARTICULARLY THE MOTHER'S BASAL METABOLIC RATE

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We have suggested in an earlier publication that under normal conditions two measures of behavior may be made during fetal life, those of the fetal heart beat and of fetal movement. Heart rate measurements were discussed in this publication; it is the purpose of the present paper to deal with the measurement of fetal activity, and of its use as a criterion of individual differences in behavior. The problem is not a new one, having been of popular interest always in connection with childbirth, and of experimental interest at least since the study of Hicks (1) in 1880. Hicks and later Ray (4) and Sontag and Wallace (8) sought to measure movements objectively by using arrangements of membranes fastened over the mother's abdomen in such a way as to be sensitive to movements transmitted through the abdominal wall. In the last mentioned study, it was suggested that although the use of such instruments was undoubtedly more objective, it was perhaps less accurate than simply utilizing the mother's report of activities as she noticed them. Beside an increased sensitivity of the mother's report technique, there is the additional advantage that records may be made over much longer periods of time since the mother is in no way hampered in her movements by the encumbrance of apparatus.

Obviously the use of the mother's report has definite handicaps from the viewpoint of scientific method. We know nothing of the maternal threshold for noticing fetal movement, of the extent to which a given mother's reliability of report may vary, or of the nature of the discrimination required. How often may fetal movements seem to be intestinal movements, or vice versa?

The one direct method of checking the mother's accuracy--that of taking mechanical or observational records simultaneously with the mother's report--may be supplemented by other indirect methods. We may check the mother's accuracy in other types of report, test her sensory thresholds (for example, tactual sensitivity in the abdominal region). Another method is to determine whether or not the mother's report is correlated with an external factor more obviously related to fetal activity than to mother's reliability. In the present report the last mentioned validation has been used. It is clear, however, that much needs to be understood about the reliability of the mother's report over and above what we know at present. To this end we hope to study the factor of mother's sensitivity to fetal movement as a psychophysical problem of itself.

Subjects. Seventeen mothers were used in these studies of fetal activity. The numbers of records per mother varied from one to seventeen. Records were taken during the last twenty weeks of pregnancy, and for most subjects represented a fairly regular time sampling.

Method. Mothers reported to the laboratory usually either weekly or bi-weekly for periods of from five to six hours. They came at about 9 to 9:30 A.M. and stayed until 2:30 or 3 P. M. During this period, excepting for visits to the bathroom, they remained in bed, where they were served lunch and were permitted to read, sew, manicure, or converse as they chose. Everything was done for the mother to make her feel comfortable and relaxed. On a few occasions records of fetal heart rate, or physical examination by the Fels physician were allowed to interrupt this schedule, the mother remaining in bed none the less.

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Two pushbuttons were manipulated by the mother; one recorded movements of the fetus as the mother noticed them, the other was used to indicate her own activity. A signal system was devised for this second button, so that the mother pushed it twice for bathroom, four times for reading, five for sewing, etc. One push indicated the end of any type of maternal activity. Instructions were carefully given to the mother as to the signal system so that its detail was clear to her.

A polygraph was used for recording the signals. In addition to a magnet for each pushbutton, a third magnet was used as a time-line, indicating minutes. Since the study was to cover relatively long time samples, the unit of measurement was minutes active; any movement reported by the mother during a single minute was sufficient for it to be treated as an active minute. The use of minutes active rather than number of movements per unit time eliminates the problem of discreteness of movements, but it is well to realize that the minutes active criterion is not an index of absolute amount of activity. Actually, the measurement secured should be thought of as the minutes during which, according to the mother, the fetus seemed to be at all active.

Ten minute periods were selected as units for the ratios of minutes active since they were sufficiently short to make possible comparisons throughout the day.

Thirty-two records, including records for all individuals and representing the whole period of pregnancy studied, were re-read to determine the actual number of movements reported by the mother. Scores for these records in terms of movements per minute were correlated with the scores in terms of minutes active per ten minutes. The Pearson coefficient of correlation obtained was .93 ±.015, indicating that the minutes active criterion of activity used in this study was a good index of the absolute number of movements reported by the mother.

To determine the reliability of the technique for reading the polygraph records taken, fifteen records were read independently by two persons. The percentage of agreement between these two determinations of minutes active per ten minute period was 95.8 per cent. The percentage of agreement for number of single minutes active was 99.5 per cent. Between the two readings of time spent in different maternal activities the agreement was 91.8 per cent. The two sets of means calculated for the fifteen records showed a rank difference correlation of .99 ±.004.

RESULTS

INDICES OF ACTIVITY[2] FOR INDIVIDUALS AND FOR THE GROUP

In Table 1 are presented the individual and group means and standard deviations of number of minutes active in ten minute periods throughout the day, for all records. It is obvious that by moving the decimal place one point to the right, the units in Table 1 could be considered percentage of time active.

Means and standard deviations of activity scores for the entire group of seventeen individuals are summarized in Table 2. It will be seen that there is a tendency for activity to rise to a peak at about the eighth to ninth month, dropping off after that point. This tendency is not simply an expression of sampling error, as will be indicated by examination of individual graphs for activity presented in Figure 1. However, all individuals do not show this

[2]The terms "activity" or "minutes active" hereafter will be used to indicate activity as reported by the mother.

TABLE 1

MEANS, STANDARD DEVIATIONS (SIGMA), AND NUMBERS OF 10 MINUTE PERIODS OF OBSERVATION, FOR MINUTES ACTIVE PER 10 MINUTE PERIOD DURING VARIOUS MONTHS OF PREGNANCY

Subject	Days before birth	Mean	Sigma	Number	Days before Birth	Mean	Sigma	Number	Days before Birth	Mean	Sigma	Number	Days before Birth	Mean	Sigma	Number	Days before Birth	Mean	Sigma	Number
1	2	2.76	2.38	33	37	2.87	2.67	31	72	1.65	1.86	34	86	2.22	2.52	32				
	9	2.00	1.58	28	44	3.42	2.61	31	79	1.58	1.64	31	93	2.74	2.93	31				
	16	1.68	1.69	31	51	2.43	2.23	14					99	2.09	1.77	35				
	23	2.11	2.20	27									107	2.12	1.85	33				
	25	3.07	1.67	14									111	2.13	1.82	30				
Mean	15	2.32	1.90	26.6	44	2.91	2.50	25.3	75.5	1.62	1.75	32	99.2	2.24	2.00	32.2				
2	12	2.94	2.31	17	40	3.43	2.21	28	68	2.65	2.37	20	96	4.16	2.34	19	127	1.84	1.95	19
					52	3.10	2.47	20					110	3.09	2.50	11				
					54	3.17	2.46	23												
Mean	12	2.94	2.31	17	48.7	3.23	2.38	23.7	68	2.65	2.37	20	103	3.62	2.42	15	127	1.84	1.95	19
3	2	2.89	1.69	18	38	2.77	2.60	31	59	3.19	2.42	36	87	3.69	2.61	36	117	2.70	3.00	20
	7	3.94	2.73	16	45	3.69	2.47	36	67	2.72	2.45	36	96	2.70	2.01	37	122	2.42	2.50	26
	16	2.85	2.76	27	52	3.76	3.08	29	73	4.03	2.59	30	112	2.20	2.11	30				
	23	3.26	2.58	23																
Mean	12	3.22	2.44	21	45	3.41	2.70	32	66.3	3.31	2.47	34	98.3	2.86	2.24	34.3	119	2.56	2.75	23
4	5	1.78	1.23	18	33	3.14	2.60	36												
	22	2.26	2.10	35	39	3.36	2.71	36												
	26	2.14	1.93	28	43	4.13	2.71	32												
					47	3.53	2.52	36												
Mean	17.7	2.06	1.75	27	40.5	3.52	2.64	35												
5	15	4.89	2.25	36	43	6.64	2.64	22	57	6.22	2.36	36	92	6.32	2.57	37	113	4.86	2.29	37
									78	6.77	2.56	26	106	5.94	2.19	36				
Mean	15	4.89	2.25	36	43	6.64	2.64	22	67.5	6.50	2.46	31	99	6.13	2.38	36.5	113	4.86	2.29	37
6	4	1.38	4.22	29	32	1.75	1.86	32	59	1.86	2.14	31	90	2.37	2.07	31	117	.64	.96	31
	18	1.26	1.20	32	45	2.57	2.60	28	76	2.71	1.91	31	97	1.40	1.85	25	124	.90	1.20	31
													103	1.71	2.26	35				
													110	1.00	1.49	19				
Mean	11	1.32	2.71	30.5	38.5	2.16	2.23	30	67.5	2.28	2.02	31	100	1.62	1.92	27.5	120.5	.77	1.08	31
7	26	.70	1.15	27																
Mean	26	.70	1.15	27																
8	3	3.79	2.31	29	31	4.96	2.37	27												
	17	3.53	1.81	32	55	4.16	2.74	32												
	28	3.64	2.92	31																
Mean	19.3	3.65	2.35	30.7	43	4.56	2.56	29.5												
9	1	.90	1.08	30	30	2.25	2.36	36	58	4.36	2.72	36								
	9	1.38	1.57	26	35	1.30	1.60	27	65	3.06	2.29	36								
	16	1.61	1.55	36	44	2.24	2.19	33												
	21	1.72	1.84	32	51	3.34	2.16	35												
Mean	11.8	1.40	1.51	31	40	2.28	2.08	32.8	61.5	3.71	2.50	36								
10	7	3.10	2.08	31	35	2.39	2.31	33	63	2.86	2.24	36	91	2.33	1.72	36				
	21	4.29	2.85	34	42	3.21	1.98	34	70	3.16	2.72	37	98	3.14	2.12	36				
					49	4.24	1.97	33	77	4.32	2.46	37	105	2.78	2.26	37				
					56	3.15	2.47	27	84	3.55	2.04	31								
Mean	14	3.70	2.46	32.5	45.5	3.25	2.18	31.8	73.5	3.47	2.36	35.2	98	2.75	2.03	36.3				
11	14	6.27	2.77	22	33	4.91	2.62	23	61	3.68	2.80	31								
	28	5.41	3.45	22	42	3.21	2.47	28												
					54	4.60	3.24	30												
Mean	21	5.84	3.11	22	43	4.24	2.78	27	61	3.68	2.80	31								
12	20	2.09	1.83	33					74	.83	1.37	23	101	1.07	1.10	14				
									84	1.62	1.41	24								
Mean	20	2.09	1.83	33					79	1.22	1.39	23.5	101	1.07	1.10	14				
13	7	2.33	1.49	33	41	2.16	1.83	31												
	14	3.27	2.76	11	55	1.41	1.06	32												
	28	2.18	1.68	33																
Mean	16.3	2.59	1.98	25.7	48	1.78	1.44	31.5												
14	5	4.53	2.32	30	33	2.81	2.02	32	68	5.06	2.55	31								
	19	3.93	2.56	30	40	4.07	2.80	29												
	26	4.16	2.88	25	47	2.33	1.88	30												
Mean	13.3	4.21	2.59	28.3	40	3.07	2.23	30.3	68	5.06	2.55	31								
15	1	5.56	2.46	27	32	3.38	2.66	32	58	4.31	2.65	26	86	4.13	2.55	31	114	2.27	1.90	30
	11	4.56	3.12	16	37	5.06	2.65	31	65	4.19	2.55	32	107	2.52	2.09	31	129	2.00	1.54	37
	18	3.56	2.92	32	44	4.25	2.87	32	71	4.97	3.41	33					137	1.35	1.36	26
	25	3.00	1.86	34	51	5.25	2.52	28	78	4.42	2.70	31								
Mean	13.8	4.17	2.59	27.2	41	4.48	2.68	30.8	68	4.47	2.83	30.5	96.5	3.32	2.32	31	127	1.87	1.60	31
16	10	2.52	2.06	25	31	3.00	2.44	30	61	3.55	2.45	31	87	3.71	2.56	31	115	2.86	2.72	22
	17	2.84	2.41	33	45	4.97	2.71	31	73	3.65	2.17	29	101	3.76	3.13	25	129	1.72	1.89	22
Mean	13.5	2.68	2.24	28	38	3.98	2.58	30.5	67	3.60	2.31	30	94	3.74	2.84	28	122	2.29	2.30	22
17	20	2.97	1.66	34	29	3.54	2.62	28												
					35	3.89	2.46	36												
					46	3.84	2.51	25												
					56	4.59	3.10	34												
Mean	20	2.97	1.66	34	41.5	3.96	2.67	31												

TABLE 2

SUMMARY OF ACTIVITY SCORES

Month	Number of Subjects	Mean	Standard Deviation
Sixth	6	2.36	1.24
Seventh	9	3.04	1.38
Eighth	12	3.46	1.40
Ninth	15	3.56	1.15
*Tenth	16	3.13	1.20

*This includes the one record on subject 7. Since she was considered only in the last month, she was eliminated from this month to month comparison. Her mean activity score was very low, .70.

tendency. Subjects 1, 11, 14, and 15 definitely showed a rise in the activity curve in the last month.

Variation within the group is relatively constant throughout the last months of fetal life. There is a tendency for it to drop in the ninth month, which fact is impossible of explanation at this point. It may be due to some factor of sampling. Deviations for individuals (Table 1) show, when averaged, the same tendency as does the group mean. Variation within the individual from record to record tends to increase slightly, and to drop off in the last month. These differences are insignificant, however.

RELATION OF FETAL ACTIVITY TO MATERNAL ACTIVITY

A comparison of the scores for fetal activity during periods when the mother was reading, sewing, lunching, and unoccupied yielded statistically significant differences only between lunch and other periods. In order to control the influence of age, fetal activity during only the last two months was used in these comparisons. Fetuses seemed equally active when the mother was occupied in any way but eating; during the lunch period they were reported as significantly less active. The most likely explanation of this finding is either that the mother's attention is more distracted from fetal movement by eating than by reading, sewing, or any other activity, or that some postural accompaniment of eating in bed is important in reducing the amount of activity reported. An approximation of the posture required for eating in bed--sitting up--is used for sewing, manicuring, writing, and also to some extent in reading. However, from observation, it appears that the mother's posture is more erect for eating than for any other activity. A suggestion from our work to date is that our methods of recording maternal activity in these broad and unqualified categories is too gross to pick up any relationships between maternal and fetal activity which may exist. We hope in later studies to measure features of maternal posture, fatigue, excitement, and the like in an attempt to correlate these more accurately with fetal activity. At present it is unwise to conclude that maternal activity is demonstrably effective in modifying fetal activity.

RELATION OF FETAL ACTIVITY TO TIME OF DAY

A careful analysis of all records in terms of time of day yielded no consistent covariation. There was a tendency for activity to show only a drop during the mother's lunch period, which drop we have discussed above in connection with maternal activity. It is possible, of course, that fetal activity may show some tendency to diurnal or other rhythm which our technique does not suffice to demonstrate. However, the work of Irwin (2) and others with

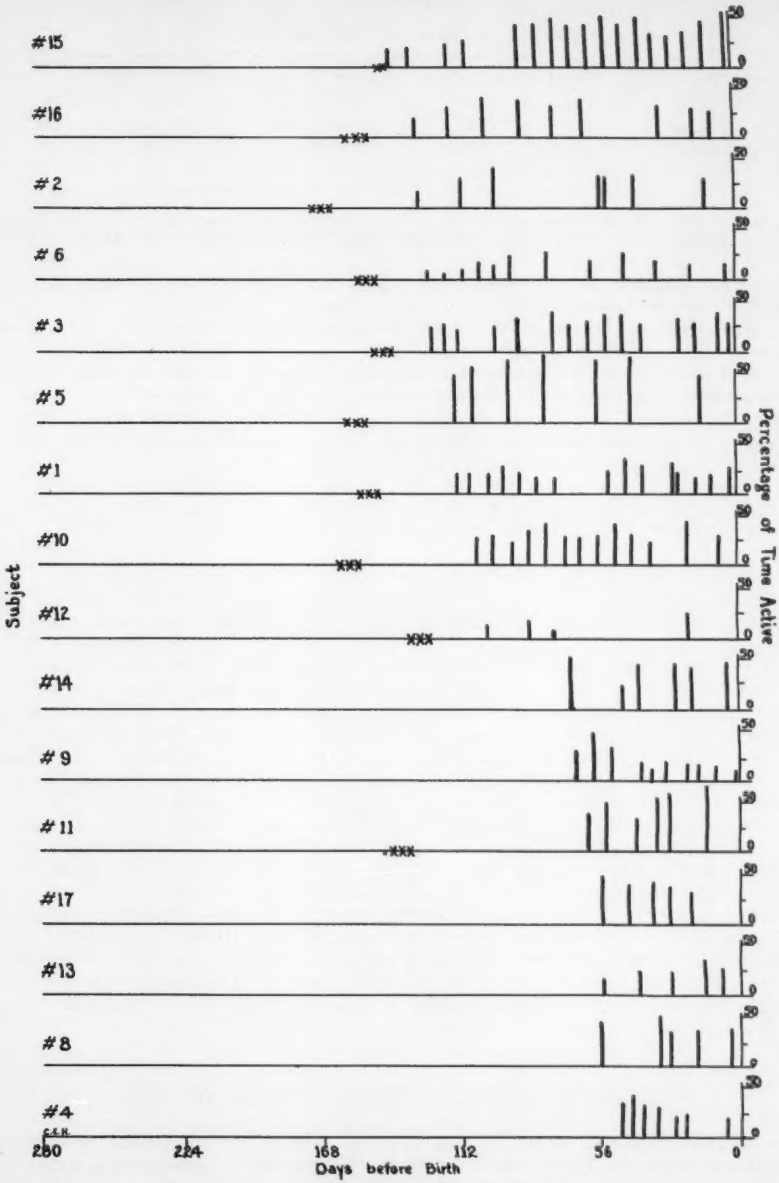

Figure 1.-Bar charts for individual fetuses illustrating the percentages of time active for different days during pregnancy. xxx denotes period during which movements were first noticed by the mother.

newborn infants indicates that diurnal rhythm does not appear until the regular feeding schedule is established. This evidence has been reviewed by one of us (6). Considering these findings with the newborn infant we should expect a diurnal rhythm of fetal activity perhaps only in connection with any such rhythm of the mother. Diurnal rhythm of fetal activity, if it exists, would very probably arise on the basis of nutrition, and considerable evidence suggests that under conditions of adequate supply the absorption of food by the fetus tends to be regular rather than periodical.

FETAL ACTIVITY AND THE MOTHER'S BASAL METABOLIC RATE

It is generally well accepted that the basal metabolic rate, BMR, increases for the average woman during pregnancy. That is, the mother's metabolism increases over and above what would be expected on the basis of weight gain alone.

For all mothers studied in this group basal metabolic rate determinations were made by means of the closed system (respiratory) method. The Sanborn Motor Graphic apparatus and Mayo Clinic norms (7) were used in obtaining rates. In this analysis, three new cases were added to increase the size of the group.

In Table 3 appear the ages, heights, weights, and BMR's for nineteen mothers. It will be seen that nine had determinations three times during pregnancy, eight had two, and two subjects had but one.

TABLE 3

MATERNAL AGES AND HEIGHTS; PRENATAL AGES*, WEIGHTS, AND BASAL METABOLIC RATES (BMR) DURING PREGNANCY

Subject	Age	Maternal Height (cm.)	Prenatal Age* (days)	Maternal Wt. BMR (Kg.)	Prenatal Age (days)	Maternal Wt. BMR (Kg.)	Prenatal Age (days)	Maternal Wt. BMR (Kg.)
1	27	155	198	59.0 - 1.0	111	64.0 + 6.5	18	70.8 +13.9
2	30	162	128	58.0 - 7.5	117	59.4 - 6.5	25	63.0 +22.2
3	15	**	114	46.0 + 3.6	87	50.8 + 5.0	31	56.9 +15.1
5	30	152	196	52.2 -19.3	112	56.7 0.0	20	64.0 +12.6
6	26	161	202	45.4 + 8.9	99	52.2 + 1.1	11	55.8 + 6.2
10	25	171	190	59.4 - 8.2	108	63.5 - 3.3	23	68.0 +18.6
12	19	165	124	57.1 -12.7	63	59.9 - 4.8	10	65.3 - 2.3
16	34	165	181	68.0 - 8.4	101	72.6 + 8.6	10	82.1 +18.0
20	24	159	206	51.2 - 2.7	92	58.0 - 1.5	9	62.1 + 1.5
7	36	159	176	68.0 + 2.4	87	73.5 + 6.5		
8	33	159	102	55.3 0.0	17	60.8 + 7.5		
9	26	153	57	59.4 +31.6	35	61.7 +40.6		
11	30	171	153	52.2 - 6.1	69	54.4 + 1.0		
13	34	165	91	81.6 + 2.2	14	84.8 - 2.5		
18	26	163	114	65.8 +13.3	24	69.8 +31.5		
14	24	163	75	64.8 + 5.7	23	68.0 - 0.5		
15	27	164	86	54.0 - 7.8	31	56.7 + 2.0		
19	17	166	19	66.2 - 4.4				
17	27	166	19	74.8 + 7.7				

*days before birth
**153 used for calculation of BMR for first two determinations; 155 for third determination.

Basal metabolic rates obtained during the last two months of pregnancy were correlated with fetal activity in the last two months and yielded a rank difference coefficient of +.19 ±.17. This coefficient does not represent the relationship between simultaneous measurements of fetal activity and maternal BMR; it expresses the relationship between levels of maternal metabolism and

fetal activity during the last two months. Hence on this basis as well as for several other reasons, it is not strictly comparable to reported (5) coefficients of correlation between metabolism and activity of infants as measured on movable beds. Another reason for the doubtful validity of the comparison of fetal and postnatal interrelationships between metabolism and activity is the fact that one is not certain as to how to partial out the weight factor in each case. The relative degree to which surface area is effective in determining metabolism in each case is an unknown proposition. That is, the degree to which the fetus (aside from the placenta and hypertrophied uterus) may alter the mother's surface area is hardly comparable to the absolute surface area of the infant.

A third reason for the invalidity of such a comparison is the fact that, in the case of fetal activity, we are dealing with the mother's report and not with an absolute quantity. For this reason, it seemed more logical to determine the difference in basal metabolism between two points in pregnancy and calculate this difference as an increment of age. The rank difference correlation between such an increment over at least one month in maternal metabolism (the increment from the earliest to the latest BMR, excluding case 9 who had but a 22 day interval between tests) and fetal activity, for sixteen cases was $+.60 \pm .11$. This is a fairly large coefficient, and quite reliable. Its interpretation is difficult, however.

One explanation of this relationship between maternal BMR and fetal activity in the last two months might be that there was considerable probability that the fetus who had a relatively high level of activity during the last month was also more active during the eight minute period during which the BMR determination was made. In that case the increase in maternal BMR might be attributed to some extent to the fetal movement themselves. However, simultaneous measurements of the two phenomena were not made, and it would be more parsimonious to disregard such an interpretation. Actually the movements noticed by the mother probably express but a very small part of the activity of tissue responsible for oxygen exchange, and even of the total activity of the fetus.

A second interpretation of the correlation of +.60 between fetal activity and change in maternal BMR is to regard the heightened metabolism of the whole mother-child relationship. As the mother's processes are more greatly accelerated, so are those of the parasite. This situation of accelerated metabolism in a growing system may indicate a rapidity of growth itself, perhaps largely of the fetus. Our criterion of growth in this case would not be growth of mass, as indicated by mother's weight gain (since this already is partialled out) or by weight of the child. Birth weight was seen to correlate with fetal activity only $+.26 \pm .16$. The accelerated growth suggested in this case would be a more physiological growth,--a growth of metabolism itself, and, as an expression of this metabolism, of skeletal activity.

If this interpretation is a valid one, then the metabolising system during pregnancy should be regarded as a unit. Just as we would not ask what part of the mother's BMR was caused by her heart beat, so we would not wonder what part was due to the fetus bodily activity. The mother who manifested a heightened BMR might consume more oxygen at a given moment because of any one of a number of processes. Of these processes, skeletal activity of the fetus might form only a small part. Consequently, we might not expect a fetal movement to register as so much increase in oxygen consumption[3]; it might form part of

[3]The only experimental evidence we could find on this point was on the basis of personal communication from Dr. Grace McLeod. Three pregnant subjects indicated fetal movement during respiratory basal metabolism determinations by pressing the thumb and forefinger together, the two phenomena recording simultaneously on a kymograph. She says that "with two of our subjects (we) saw no consistent effect at all. A few times we thought we saw an increased oxygen consumption in a test period following one in which there had been considerable fetal movement, but on the other hand, there were many periods following periods of fetal activity in which we saw no change whatever, and in no case was the change so great as to be at all significant in comparison with the usual variations from period to period."

the general acceleration of metabolism. On the other hand, this acceleration of metabolism during pregnancy might be accounted for at any one point by factors entirely apart from fetal movements as they are noticed by the mother.

EFFECTS OF AGE ON ACTIVITY OF THE FETUS

Figure 1 presents graphically fetal activity for all individuals. No entirely consistent trend is apparent. It is seen, however, that the curves tend to originate at or later than the fourth to the fifth month, to rise to their highest point at about the eighth to the ninth month, and, in several cases at least, to drop off from this point to the end of pregnancy. The point at which fetal movement is first noticed by the mother is shown in some of these graphs; the data here are consistent with the usual obstetrical finding that quickening is noticed at the fourth to fifth month. It is also held generally by obstetricians that the fetus is less active just before delivery than during the preceding weeks. We cannot interpret the tendency for this drop in activity to be a consistent one applying to all our cases. If it exists as a real phenomenon, it might be explained in any one of at least three ways. Increasing head pressure might serve to inhibit bodily activity of the fetus. Again, the fetus' relative size in the last months of uterine life may actually alter the amount of movement in that there is less spatial capability of movement, or movements thus restricted may occur as frequently but be less in amplitude and so less stimulating to the mother. The third possibility is that concomitantly with the last stages of preparation for delivery uterine sensitivity itself may be altered so as to increase the mother's threshold.

Correlations between ranks of various fetuses at different months of uterine life are presented in Table 4. It is seen that these coefficients tend to range from +.56 to +.88 indicating considerable consistency in placement with respect to the group at various points.

TABLE 4

INTERCORRELATION BETWEEN RANKS IN FETAL ACTIVITY SCORES AT VARIOUS MONTHS DURING PREGNANCY. CORRELATED RANK DIFFERFNCE COEFFICIENTS

		FETAL ACTIVITY LUNAR MONTH				
		6	7	8	9	10
6	r		+.62 ±.18	+.74 ±.13	+.74 ±.13	+.73 ±.14
	N		6	6	6	6
7	r			+.84 ±.07	+.88 ±.05	+.68 ±.13
	N			9	9	9
8	r				+.56 ±.15	+.65 ±.12
	N				13	11
9	r					+.71 ±.09
	N					15
10	r					
	N					
9 & 10	r	.78 ±.11	+.78 ±.09	+.76 ±.08	+.88 ±.04	+.95 ±.02
	N	6		13	15	17

As may be inferred from the age data thus far presented, there seems to be no obvious tendency for activity to increase to any extent after about the seventh month. A correlation between activity within the last two months of fetal life and the mean age at which these records were obtained calculated on the basis of days since last menstruation yielded a rank difference coefficient for eighteen[4] cases of +.207 ±.19.

[4]For three of the total group of seventeen subjects upon whom this report is based data was lacking; however, four new subjects were added to give a total group of eighteen. Thus, this is a group comparable to but not identical with the group used in the remainder of the study.

RELATIONSHIP BETWEEN FETAL HEART RATE AND FETAL ACTIVITY

Heart rate records for all fetuses were taken periodically during pregnancy. The mean heart rate represents the level of heart rate for a relatively long period, just as the mean activity for a number of records represents a level of activity. The rank difference coefficient for mean heart rate during the last two months and mean percentage time active for the same period, for the 17 subjects was -.22 ±.17, suggesting that there is no significant relationship.

It is well known that normally activity increases the heart rate. The failure to find a high positive correlation between fetal heart rate and activity measures here reported means only that in this group at least, the characteristically most active individuals were not necessarily those with the highest average heart rate. Our heart rate records are not taken in such a way as to afford the best correlation with activity. A simultaneous record of activity and heart rate is at present impossible under standard conditions. Until such records can be obtained it will be difficult to study this relationship critically.

OTHER RELATIONSHIPS

Rank difference coefficients between body length and body weight at birth with mean activity scores during the last two months of fetal life for sixteen subjects yielded coefficients of +.31 ±.14, and +.26 ±.16 respectively, indicating no relationship. Irwin (3) obtained coefficients with stabilimeter measurements of bodily motility of 73 newborn infants .05 ±.08 for birth weight and .02 ±.08 for weight at the time of experiment. For crown-heel length, his coefficient with motility was .030 ±.08. Motility correlated .20 ±.08 with body surface calculated according to the Lissauer formula; using the Du Bois and Howland formulae he obtained coefficients of .17 ±.08 and .14 ±.08 respectively. Comparing these with our coefficients for fetal activity it is clear that the lack of relationship between activity and physical proportions found for fetuses is in keeping at least with these data for newborn infants.

DISCUSSION AND SUMMARY

From the foregoing material it is apparent that many more problems are raised than settled by these studies of fetal activity. A list of certain questions we hope to approach as sequel to this study might be arranged as follows:

(1) What is the error of the mother's report? Do differences between mothers account for much of the differences between their reports of fetal activity?

(2) Would a concentration of time-sampling during the first weeks of fetal movement clarify our understanding of the developmental curve for fetal activity?

(3) How much does maternal posture affect the activity of the fetus, or the mother's sensitivity to fetal movement? What is the effect of fatigue, of emotional excitement?

(4) Would a simultaneous measurement of maternal metabolic rate and fetal activity clarify the relationship between general levels of these phenomena, as here reported? In similar manner, can a readaption of time-sampling and other technical factors clarify the relationship between fetal heart rate and activity?

This first analysis of fetal activity as reported by the mother has a number of technical limitations, involving the reliability of mother's report. It fails to show significant differences in activity thus reported which may be due to sex,

para, age, and maternal activity. Although differences are not statistically significant, it is possible that there is a peak of activity during the eighth and ninth lunar months, with a dropping off at the tenth month. As may have been anticipated from the evidence with newborn infants, there was no evidence of diurnal or other rhythm in this reported activity.

When fetal activity level during the last two months was correlated with the mother's basal metabolic rate sampled during the same period a coefficient of .19 ±.17 was obtained. However, the correlation, not with absolute basal metabolic rate but with the increase in metabolic rate over measurements taken 52 to 197 days earlier, was .60 ±.11. This coefficient does not in any way indicate that fetal movements as single units of any sort account for the rise in metabolic rate, but suggests that both BMR and fetal activity measures are indicators of heightened metabolism of the mother-child unit.

We may conclude from this material that the method of measuring fetal activity simply by sampling the mother's report over relatively long periods is a technique of much potentiality for studying normal behavior at this little-understood period. The reliability of the method deserves further study, but it is possible that it may be more sensitive, and it is obviously more practicable than is the use of mechanical devices so far described. The report in this series which follows the present one will suggest that the method possesses a certain degree of validity, as evidenced by the possible correlation with a criterion of postnatal behavior.

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STUDIES IN FETAL BEHAVIOR: III. CAN PERFORMANCE ON TEST ITEMS AT SIX MONTHS POSTNATALLY BE PREDICTED ON THE BASIS OF FETAL ACTIVITY?[1]

T. W. RICHARDS AND HELEN NEWBERY[2]

How early in life do individual differences occur, and how prognostic are they of later differences in behavior? Aside from such studies as those of Muhlenbein (11), Bayley (1), and others dealing with the correlation between scores on baby tests at various age levels, little is known of such prediction. Measures of infant activity by means of the stabilimeter, and of specific responses of newborn infants have done little to establish criteria of individual differences at this earliest postnatal level. Stabilimeter measurements should very easily serve as individual scores, but almost no interest has been shown in treating them as such. And what of the fetal period? Will any demonstrable differences in activity during intrauterine life be indicative of later variation?

The techniques available for the study of fetal behavior are so crude and indirect that concern with the relationship between activity in fetal life and postnatal development would normally be postponed until a great deal of preliminary work has been done. However, in the course of such preliminary work progressing slowly with the addition of six or eight subjects per year, it was observed that the infant which had been most active as a fetus, had also shown certain motor performances earlier than most of the other children in the group, and that individuals least active as fetuses had in some cases been slow in acquiring motor skills postnatally. This observation suggested that even before more refined techniques for the study of fetal behavior could be worked out, and more detailed studies of early postnatal performance made, the evidence at hand concerning the relative activity of a group of fetuses and the data on postnatal development should indicate what the results of a more thorough study might be, and what avenues of attack would be most profitable.

A previous paper in this series (15) described the technique whereby polygraph records of fetal activity were obtained by having the mother report fetal movement as she noticed it, over a five or six hour period at one or two week intervals throughout the last half of pregnancy. The records were scored in terms of mean number of minutes active per ten minute period. This index constitutes the "score" for fetal activity. In order to hold age relatively constant, the scores used for comparative purposes are averages of records obtained only in the last two months of pregnancy.

Of the information available concerning postnatal behavior, the most comprehensive and statistically treatable was the data concerning performance on Gesell Schedules. To date twelve of the infants whose activity in fetal life was studied have taken the six-months Gesell Schedule within four days of their six-month birthday. Comparing this group of twelve children at six months with a larger group of seventy-seven on the basis of number of the forty-six Gesell items passed, the results given in Table 1 were obtained. The smaller group is seen to have a lower mean and smaller variability than the larger group. These differences are not statistically significant, however.

Six members of the smaller group have taken the twelve months Gesell items within four days of their birthdays. The relationship between prenatal and postnatal performance is calculated only for these small groups.

[1]The idea of measuring fetal behavior in the hope that it might be shown predictive of later development, both psychological and physical, was originally advanced as a research interest by Mr. Fels. His interest in this program has been greatly appreciated by the authors.

[2]From Samuel S. Fels Research Institute, Antioch College, Yellow Springs, Ohio.

TABLE 1

Group	A	B
No. of Cases	77	12
Maximum Score	46	39
Minimum Score	6	11
Mean Score	28.2	23.9
Standard Deviation	8.7	7.9

CORRELATIONS WITH THE GESELL SCHEDULE AT SIX MONTHS

Rank difference coefficients between activity scores[3] and performance on the Gesell Schedule[4] at six months postnatally were made by using the total score as described by Nelson and Richards (12). These coefficients are given in Table 2.

TABLE 2

Month	N	r
Seventh	6	.84 ±.08
Eighth	9	.65 ±.13
Ninth	11	.72 ±.10
Tenth	12	.54 ±.14
Ninth and Tenth	12	.71 ±.10

In a correlation such as that between fetal activity and performance at six months postnatally, actual chronological age is of obvious importance. Three-fifths of the six-months-old child's life is spent in the fetal period and the control of age to the extent only of the postnatal period could allow much room for error in correlations in which age may be presumed to operate. Of the group of cases for whom both activity and Gesell scores were available, only ten had accurate records of date of last menstruation. By partialling out age the correlation between activity and Gesell performance was changed from .659 to .864. but this was on the basis of only ten cases. It was decided to use maximum groups for each of the zero order coefficients, in an effort to determine indirectly what the influence of age on such a relationship might be for larger groups. The groups used in this analysis are shown in Table 3.

TABLE 3

SIGNIFICANT DATA RELATIVE TO GROUPS USED IN CERTAIN CORRELATIONS BETWEEN AGE, GESELL SCORES AND FETAL ACTIVITY

	Age-activity	Age-Gesell	Activity-Gesell
Number cases	18	72	13
Means (Age in days	248.7	460.2	
Means (Activities	3.17		3.36
Means (Gesell Score		29.2	23.2
Sigmas (Age in days	10.0	11.2	
Sigmas (Activity	1.12		1.16
Sigmas (Gesell Score		7.9	8.1
Coefficient (r_p)	.207	.294*	.663

*Pearson

[3]The terms "activity" or "minutes active" will hereafter be used to indicate activity as reported by the mother.

[4]The authors are indebted to Dr. Virginia Nelson for Gesell material at six months and twelve months.

From Table 3 it is seen that the groups are not entirely comparable in terms of mean and sigma; differences in activity are slight, but the smaller group is slightly inferior to the larger in Gesell score (critical ratio of 2).

Correlation between fetal activity and Gesell performance partialling out age when these groups were used lowered the coefficient from .663 to .644.

From these analyses we can infer, we believe, that the error introduced by using birth rather than menstrual age in controlling the age factor is not a serious one when correlating fetal activity with Gesell performance at six months. Certainly the coefficient is not raised spuriously by introducing this error.

To return to the original correlation between fetal activity and Gesell performance, it is seen that none of these coefficients is high. However, although they are based on few cases, they are consistently positive, and large enough to be reliable. The relationships among the fetal age levels and the six-months Gesell score were almost without exception as high as were the interrelationships among fetal age levels, described in the previous report (15). In other words, there would seem to be a factor or group of factors common throughout fetal life, which are still present at six months of age. The rank difference correlation between fetal activity and Gesell scores at twelve months was .62 $\pm$.18, suggesting that this common factor (or factors) does not drop out even after six months.

Another analysis of these relationships was made in the following way. The distribution of the twelve subjects according to activity in the last two months was divided into tertiles. Median scores on the Gesell Schedule at six months were calculated for each of these groups. The results are given in Table 4. It will be seen that the children in the highest tertile of fetal activity obtained the highest median Gesell score at six months, and those in the lowest tertile obtained the lowest median six months score. Because of the sparsity of cases we could not determine the significance of these differences. A suggestion of their significance is rendered by comparing the differences themselves with the sigma of total Gesell scores for these twelve children and for a larger group of seventy-seven children (12). These sigmas are 7.9 and 8.7 respectively. The differences are 13 between lowest and highest fetal tertiles, 10 between highest and middle, and 3 between middle and lowest. Thus, the lower tertiles differ from the upper tertiles by more than one sigma of the total distribution of scores.

TABLE 4

FETAL ACTIVITY SCORES

	576-402	377-290	227-174
Total Score			
Median	31	21	18
Maximum	39	35	21
Minimum	20	18	13

All of these facts bear out the suggestion of the correlation material that some factor which is operative in producing a high score for percentage of time active in fetal life, is also operative in performance on the Gesell items at six months postnatally.

The data were treated in still another way. Performance on Gesell items at six months was analysed in terms of fetal activity. This was done by comparing for each item the median fetal activity scores of those who passed and those who failed. The differences between medians of passing and failing groups are given in Table 5.

TABLE 5

Gesell Item	Median Fetal Activity Score		Difference
	Passing	Failing	
Creeps or hitches	5.76*	3.31	2.45
Drops object into cup	5.76*	3.31	2.45
Secures pellet	5.76*	3.31	2.45
Inhibits head and one hand	4.17	2.18	1.99
Sits alone	4.88	2.90	1.98
Picks up cube	3.77	1.84	1.93
Sits with slight support	4.02	2.09	1.93
Pats table	3.90	2.06	1.84
Manipulates one hand	4.02	2.27	1.75
Music: stops crying	4.02	2.27	1.75
Looks for fallen object	4.17	2.58	1.59
Crumples paper	3.40	1.84*	1.56
Dangling ring: clasps	3.40	1.84	1.56
Dangling ring: closes in	3.40	1.84*	1.56
Expresses recognition	3.40	1.84*	1.56
Prefers one hand	4.45	3.10	1.35
Conscious of fallen object	3.90	2.58	1.32
Music: laughs	3.90	2.58	1.32
Takes bottle in and out mouth	3.58	2.27	1.31
Conscious of strangers	3.40	2.09	1.31
Plays with objects	3.40	2.09*	1.31
Turns head to bell	3.40	2.27*	1.13
Reacts to mirror image	3.40	2.27	1.13
Splashes in tub	3.40	2.27	1.13
Exploratory manipulations	4.02	2.90	1.12
Reaches directly for spoon	3.00	2.79	1.11
Blinks at pencil	3.58	2.58	1.00
Paper: purposeful reaction	4.33	3.36	.97
Dangling ring: above head	3.90	3.10	.80
Makes stepping movements	3.90	3.10	.80
Regards pellet	3.90	3.10	.80
Throws objects to floor	3.90	3.10	.80
Bangs spoon - reaching	3.58	3.10	.48
Dangling ring: persistent	3.77	3.31	.46
Drops one cube for third	3.77	3.31	.46
Holds two cubes	3.36	3.14	.22
Rolls back to stomach	3.40	3.31	.09
Says "mamma", "dada"	2.88	3.36	-.48
Secures cube	2.27	3.40	-1.13
Lifts inverted cup	3.31	4.88*	-1.57
Mean			1.27
Sigma			.82

*Items passed or failed by only one subject.

It is difficult from this ranking to make any psychological explanation of what abilities are most closely related to the factors involved in fetal activity. The order in which the items appear to be predicted from fetal activity scores seems to bear no relationship to factor loadings of Gesell items as reported in another study (14). If the arrangement of items in this order is borne out in subsequent correlation using larger groups, it is planned to analyse it in detail, with the hope that it may yield some psychological significance. At present there is no explanation for the varied nature of the items which are best (or most poorly) predicted by fetal activity scores.

Due to the fact that our total group of fetuses was a small one, no attempt was made to determine critical ratios for the differences above. It will be seen that of the forty, only three are negative. Comparison of the actual size of the differences with the semi-interquartile range for the total group of fetuses on activity (0.995) shows that twenty-seven of the forty differences are greater than this measure of dispersion in the positive direction, while two surpass it in

the negative direction. Three positive differences are more than twice the semi-interquartile range.

It may also be of significance to note the distribution of fetal activity scores on items which were passed or failed by only one subject. There were nine such items. In the three cases in which the item was failed by all subjects but one, the one passing was the subject with the highest fetal activity score. In five of the six cases in which all but one subject passed, the one failing was in the lowest tertile for fetal activity. These observations add further support to the suggestion that ability to pass Gesell items may be predicted in part from fetal activity.

DISCUSSION AND SUMMARY

The evidence presented in this paper is based on observations of only twelve cases. Several statistical approaches to the material obtained agreed very closely in suggesting that for this group there was a positive relationship between fetal activity as reported by the mother and performance on the Gesell items at six months. Rank difference coefficients in all cases were four times their probable errors. No spurious age factor was found to account for these relationships.

In terms of prediction, these coefficients would indicate (according to r^2) that from thirty to seventy per cent of the variance at six months is measured by the activity records during fetal life.

At least four explanations for this correlation might be suggested. The first two of these refer to the fact that our criterion of fetal activity is based upon the mother's report of activity rather than on fetal activity actually measured. Thus, mothers who tend to report more activity during fetal life may be the mothers who endow their offspring with greater ability at six months postnatally either (1) genetically or (2) by surrounding the child with environmental factors conducive to mental development. Each of these explanations is worthy of consideration. Evidence from the literature would suggest that mental ability during the early years may be related to a broad environmental estimate such as socio-economic status or parental intelligence (1, 11), but to the authors' knowledge this has not been demonstrated for ability at six months. Indeed, Bayley's (1) work would indicate that during the early months such influence is not effective, appearing effective only later than eighteen months. How much factors such as personality traits of the mother, a tendency to notice or to report movement, etc., may contribute to such possible relationship we do not know.

The third and fourth explanations of the relationship between fetal activity and performance at six months assume that the fetal scores indicate actual variability among fetuses. The relationship may be due (3) to the facilitation of six months ability by the very exercise of function itself; the activity demonstrated by some fetuses, whatever its genesis may be, actually improves function so that the child's performance later on is facilitated. That is, the child's behavior is modified by exercise. Frequency of activity, which essentially is most likely what we are measuring at the fetal level, would seem to be analogous to an exercise function of some sort.

Regarding this explanation certain considerations are important. The activity measured during the fetal period would not seem to be in any way the same function as that measured at six months. In one instance, we are dealing with the amount of time during which activity of any sort is present; in the second instance we are dealing with responses which seem highly specific by comparison. If a training effect explains the correlation found, it is necessary to assume that this effect is in the nature of general facilitation of behavior--a sort of increase in the "g factor", due to activity in fetal life. Again the evidence

of Wenger (18), Kantrow (8), and others for conditioning during the newborn period (9) gives little comfort to the thought that learning is possible during this early stage of life. Conditioning has been reported for newborn infants, but not unequivocally and as a normal function for most children. When we consider fetal conditioning, positive evidence is even more tenuous; the few experimental studies (13, 16) have not indicated that the fetus is conditionable.

The fourth explanation of the correlation between fetal activity and infant performance at six months is that the amount of time a fetus is active is a criterion, during fetal life, of the developmental pattern or patterns of behavior responsible for rather specialized performances at six months postnatally.

A quotation from Coghill (3) is pertinent in this connection:

> "From the facts related. . . . . it is obvious that there are two processes that are operating simultaneously in the development of behavior. The one is expansion of the total pattern as a perfectly integrated unit; the other is the individuation of partial systems which eventually acquire more or less discreteness. In Amblystoma the total pattern first extends through the trunk and tail. As this pattern enlarges, the parts involved are always perfectly integrated. This totally integrated pattern then extends into the gills, next into the fore limbs and finally into the hind limbs. But as the totally integrated pattern expands through the organism, its parts, one after another, in the same order as they were invaded by the total pattern, begin to acquire a measure of individuality of their own; first the gills, the fore limbs and finally the hind limbs. This means that local reflexes emerge as, in the language of 'Gestalt', a 'quality upon a ground'; that is to say, they emerge as a special feature within a more diffuse but dominant mechanism of integration of the whole organism. They cannot be regarded as simply the action of a chain of neurones, excepting as every link of the chain is conceived to be welded into the organism as a whole." (p. 88-89).

The fetal "activity" we have measured and discussed in this paper, since it represents amount of movement in time rather than type or quality of response, may be considered only with difficulty as expressing "pattern" of behavior. However, just as metabolic rate or muscular tension may form part of a pattern, so may fetal movement expressed in this way.

Assuming that our measure of fetal activity is a sort of "test", its relationship to the postnatal test is suggested by a recently published discussion quoted from the Manual of Child Psychology by Stoddard and Wellman (17).

> "It is necessary to avoid the error of believing that things contributing to the same general function must themselves be alike or look alike. A task may be performed with or without verbalization, and the two acts appear grossly unlike, yet they may make essentially the same contribution to a pattern of intelligence. For example, the placing of one cube on top of the other by a child may contribute to the measurement of intelligence as adequately as the definition of pity fifteen years later.
>
> "In measuring intelligence, we are getting at not only ingredients of the whole pattern, but at indicators, surrogates and prognosticators. We need not bother at all about the external appearance of our tests if they are shown (a) to be, or to be related to, (b) to be surrogates of, or (c) to predict the likelihood of, intelligent behavior as defined. If the goal is not so much to measure intelligence as to analyse the whole behavior pattern of the child, we are of course justified in focusing our attention upon any practical aspect of development or behavior, such as motor skills, speech or ability in spatial relations."(p. 45)

In our fetal studies we may have evidence (somewhat humble, to be sure)

that the specialized behavior observable at six months actually emerges from a pattern of which simple frequency of response is diagnostic during the fetal period.

The fact should be mentioned that reports of Minkowski (10), Bolaffio and Artom (2), and others concerning reflex behavior of fetuses removed from the uterus indicate that specific movements may occur as early as the third month of fetal life. Thus, it is possible that our measurements of activity during the last months of fetal life, measure at that late date very little of the mass activity characteristic of Coghill's precursor to individuated, specialized responses. On the other hand, Irwin (5, 6, 7) has been vigorous in his description of "mass activity" as the most characteristic and dominant form of behavior even in newborn infants.

A final consideration is the problem of mental organization during these early months of life. A solitary attempt to find a general factor or any other factors which might account for the relation of various forms of reflex behavior in newborn infants was made by Furfey, Bonham, and Sargent (4). They failed to find correlation between such phenomena at that level and concluded that no general or other factor was evidenced. In the light of newer techniques of analysis it would be interesting to know whether the single tests used by these investigators were sufficiently reliable to measure the variance due to common factors, should these be present. A recent attempt to determine primary factors in Gesell performance at six months (14) indicated that there was at least one factor and perhaps three factors present at this level.

We should conclude this list of explanations by stating that we are open to conviction regarding any one of these possibilities, or regarding any other which may emerge. Actually, our correlation is open to much question, due to sampling error and it may disappear with more adequate sampling. At present it stands out as a finding quite unanticipated and certainly worthy of careful validation, explanation, and interpretation.

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ANATOMIC LAG[1]

WILSON D. WALLIS

By anatomic lag we refer to the tendency of an anthropometric dimension to lag, in relative value, upon another with which it is correlated. Thus, when head length as dependent variable is plotted against head width as independent variable, rate of increase in head length is less than rate of increase in head width; conversely, when head width as dependent variable is plotted against head length as independent variable, head width does not increase at the same rate as head length, but lags on head length. A similar phenomenon is observed in the case of many other paired dimensions of head or body, in most cases, it appears, with differential rates of lag. In some cases, however, the dependent variable accelerates upon the independent variable against which it is plotted, that is, increases at a faster rate than does the independent variable.

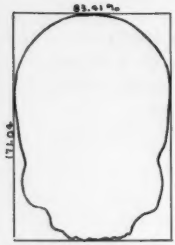
Relative rates of increase, i.e., of lag or acceleration, cannot be detected in the usual coefficient of correlation.

Examples of changes in proportion with increase in dimension are shown in the accompanying figures. Basic dimensions are reduced to the same absolute scale. The compared predicted dimension is expressed as a percentage of the basic dimension.

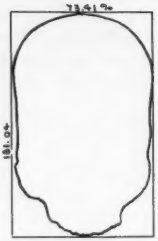
The coefficient of linear correlation is not changed if to a series of paired head length and head width we add any constant unit to each item of either or both variables; though such addition would, of course, change the relative increase of the items of a given variable. Much anthropometric work is concerned with proportions, that is, with relative values of two dimensions. If index is a function of dimension, that is, if there is lag or acceleration of one dimension upon another, then dimension must be held constant when comparing proportions between two groups if we wish to know to what extent the difference in proportion is a group phenomenon as distinct from a mere biometric phenomenon. This will apply when, for example, one wishes to determine whether group differences are attributable to some other factor or factors than sheer dimension. So far as we can ascertain, this fundamental biometric problem has not been analyzed; and no account of the principle has been taken in comparative anthropometric work.

In 1901 and 1903 Pfitzner (Ztschr.f.Morphol.u.Anthropol.,3,5) showed that proportions change with dimensions in each sex; but he seems not to have appreciated the character of the change, although all of his tabulations show distinct trends of index with increase in dimension. Many correlations published in Biometrika show that when a dimension is correlated with an index of which that dimension is a component there is a significant correlation, the sign depending upon whether the x variable correlated with y is correlated with x/y or with y/x. The meaning of these correlations, however, is nowhere indicated. In the same journal, some thirty years ago, Professor Raymond Pearl pointed out the lag in length-width dimensions of paramecium. We have seen no other application of the principle to animals, yet the following tables suggest that anatomic lag is as typical of lower animals as of man.

[1]This study was supported by a Grant-in-Aid from the National Research Council and as a subproject at the University of Minnesota under the Works Progress Administration. Clerical assistance was given by Federal Aid students at the University of Minnesota. Mathematical testing was done by Dr. Borghild Gunstad, of the University of Minnesota. The writer is much indebted to Dr. Gunstad for advice regarding formulas and procedure in analyzing and utilizing data and computations, and to Ruth Sawtell Wallis for invaluable and laborious assistance in constructing and checking the tables.

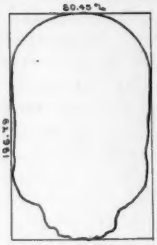


157 Peruvian, males



157 Peruvian males

1838 German, males



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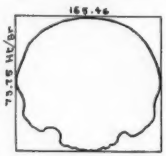
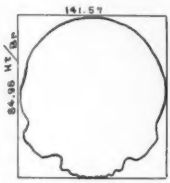
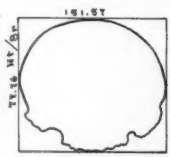
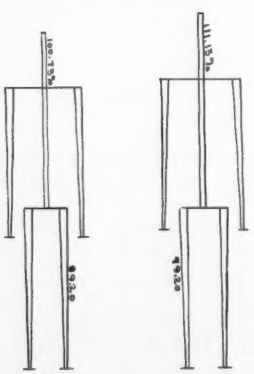


1735 German, males

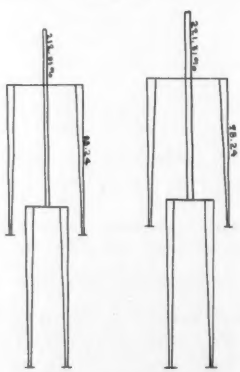




220 New Guinea males



600 German, males
Stem Length Divided by Leg Length



1273 German males
Stature Divided by Arm Length

METHODS OF ANALYZING LAG

Method of analyzing lag is to some extent dependent upon character of available data. Hence we have not been able to adopt a uniform method of presenting results of analyses.

1. Lag is shown by the correlation of a dimension with an index of which that dimension is a component; that is, of x with x/y, or of y with x/y; for example, head length with cephalic (cranial) index, or head width with cephalic index.

2. When r xy is given, r of y with x/y (I) can be derived from the formula:

$$r\ YI = \frac{r\ xy - \frac{Vy}{Vx}}{\sqrt{1 - r^2 xy + \left(r\ xy - \frac{Vy}{Vx}\right)^2}}$$

Testing with data in which the correlation of YI has been made directly shows that this formula gives the r of YI with close approximation in large series, that is, within .05. Many of our coefficients have been computed directly from dimension and index, and many have been computed by the last formula.

TABLE A

COEFFICIENTS OF CORRELATION BY ABOVE FORMULA AND BY DIRECT CORRELATION OF Y WITH $\frac{x}{y}$. DATA OF SCHUSTER, OXFORD UNDERGRADUATES, LIVING MALES (BIOMETRIKA, 8)

No.	Age	r of Stature-$\frac{\text{Leg length}}{\text{Stature}}$		Difference
		By formula	From raw data	
129	18	.42	.44	-.02
330	19	.35	.37	-.02
209	20	.39	.42	-.03
137	21	.48	.50	-.02
95	22	.40	.45	-.05

3. Lag or acceleration of dimension is indicated also in the prediction formulas r xy $\frac{Vx}{Vy}$ and r xy $\frac{Vy}{Vx}$, a modification of the usual regression formula, in which for S.D., absolute variability, V, or percentage variability, is substituted. Thus if r xy (Vx/Vy) is 1, there is no lag or acceleration of x on y. The relative regression coefficient r xy $\frac{Vy}{Vx}$ indicates percentage change in y for 1 per cent change in x. Amount of lag, therefore, is inversely as the value of r xy $\frac{Vx}{Vy}$, or of r xy $\frac{Vy}{Vx}$, the relative regression coefficients.

A value above 1 indicates percentage acceleration.

Thus: $x-\bar{x} = r\ xy \frac{\text{sigma } x}{\text{sigma } y}(y-\bar{y})$; $\frac{x-\bar{x}}{\bar{x}} = r\ xy \frac{\text{sigma } x}{\text{sigma } y}\frac{1}{\bar{x}} \cdot \bar{y}\ \frac{y-\bar{y}}{\bar{y}}$;

$x-\bar{x} = r\ xy \frac{\text{sigma } x}{\text{sigma } y} \cdot \frac{\bar{y}}{\bar{x}} \frac{y-\bar{y}}{\bar{y}}$; $x-\bar{x} = r\ xy \frac{Vx}{Vy}$.

Similarly, $\frac{y-\bar{y}}{} = r\ xy\ \frac{Vy}{Vx}$. Or, if each item of x1 x2...be divided by $\bar{x}$, and each item of y1 y2...be divided by $\bar{y}$, we reduce each item to a percentage of the mean, and do not change the value of the coefficient of correlation. Thus $r\ xy = r\ \frac{x}{\bar{x}}\ \frac{y}{\bar{y}}$ and the regression, r xy Vx/Vy gives percentage change in x for 1 per cent change in y.

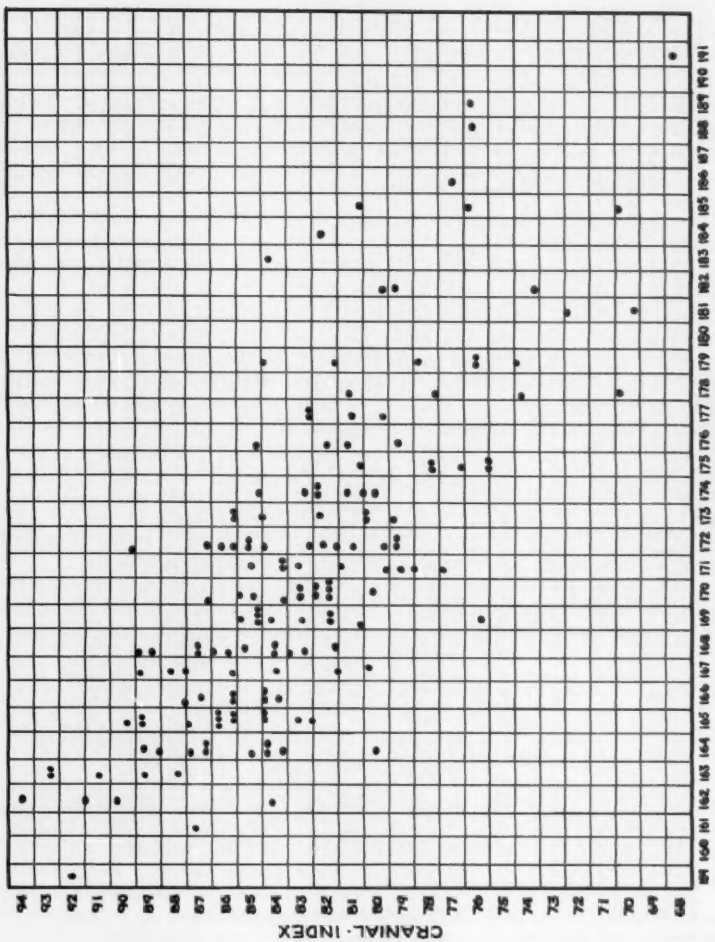
4. From series which do not permit derivation of coefficient of correlation we computed regression of index upon dimension, or conversely. The sign of regression indicates presence or absence of lag, and its value indicates degree of lag.

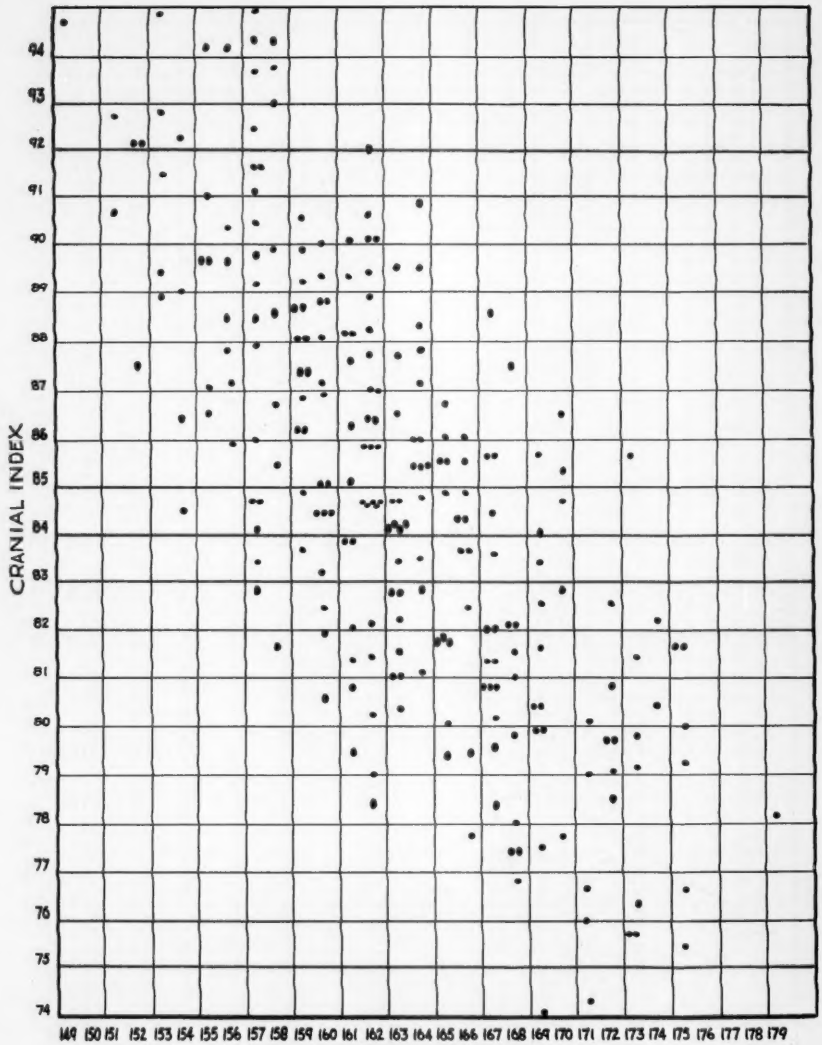
5. Inasmuch as the relative regression coefficient expresses rate of change of one variable against another, it is possible to compare them in an index or ratio. Thus if the relative regression coefficient of lag of head breadth on head length is .20, and of head length on head breadth is .40, the ratio is $\frac{.20}{.40}$ or .50. Such a ratio or index makes easily comparable the ratio of lags of two given variates in different series, and ratios of lag of various dimensions against a given dimension, as for example, head length against head breadth, or head height, or face breadth, or face height, and so on.

Inasmuch as ratio of lags of paired x and y expresses ratio of percentage increase in respective variables, it follows that the ratio indicates type and amount of change in the index of which x and y are components; and thus discloses the trend in these proportions prior to or during the age period analyzed. Thus if the lag of (x) head breadth on (y) head length is the same as the lag of head length on head breadth, then increase in size of head, as measured by these two dimensions, does not result in a change in breadth/length index. If, however, the ratio (lag of x/lag of y) is less than 100, increase in size of head is accompanied by a lowering of breadth/length index; whereas a ratio above 100 indicates increase in breadth/length index. It should be remembered, however, that (1) most of our data deal with end-points of growth, in adults, or with a small age range in the pre-adult period; and (2) there are age changes during adult life. The data, therefore, do not disclose whether we are (1) merely recording changes which have previously occurred and have persisted into subsequent age levels, or (2) are observing changes within an age group, or (3) both.

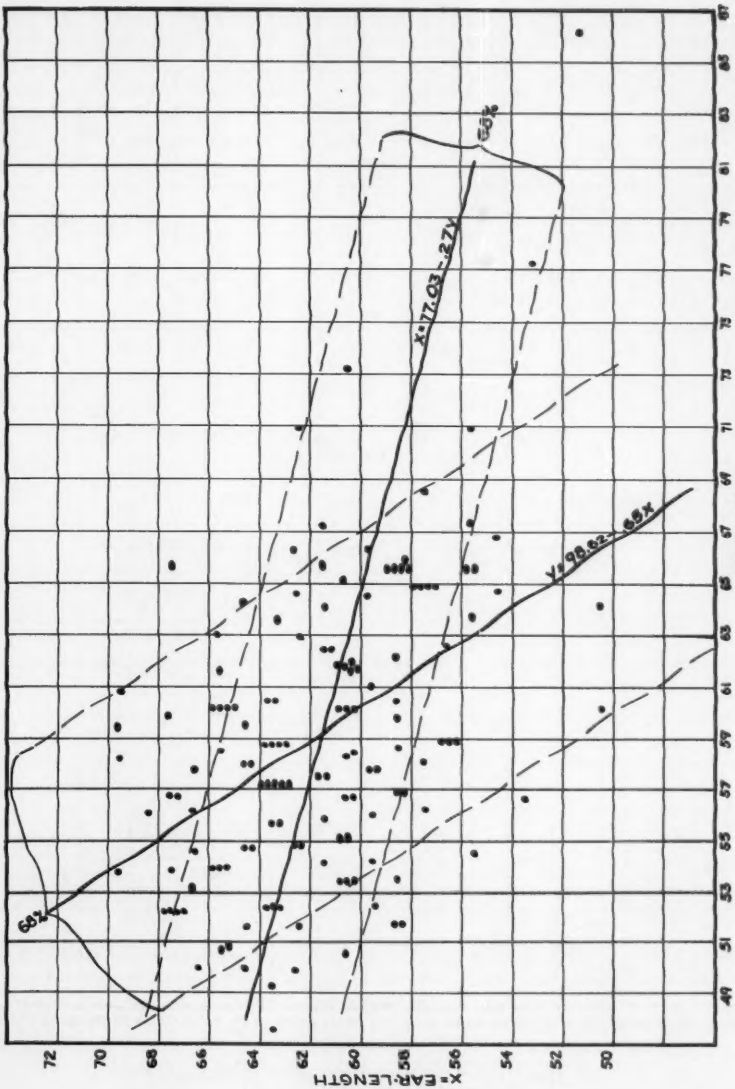
TESTS OF LINEARITY FOR DIMENSION AND INDEX

Inasmuch as the legitimacy of our correlation of dimension and index depends upon linearity of the variables, we tested the linearity in three series. For cranial length and cranial index presented in a scatter diagram and in a correlation table for a series of 157 Peruvian male skulls and 242 female skulls (Sankas, Am. J. Phys. Anthropol., 14:309-315, 1930) the relationship is linear. A correlation table of head breadth and cephalic index in a series of 220 living natives of the North Coast of New Guinea (Pöchs Nachlass, Series A, II, 172-176) shows a similar linear relationship. A scatter diagram of ear length and ear index in 145 Peruvian males (Ferris, Am. Anthropol. Assoc. Mem., 3:106-121, 1916) shows less marked linearity.

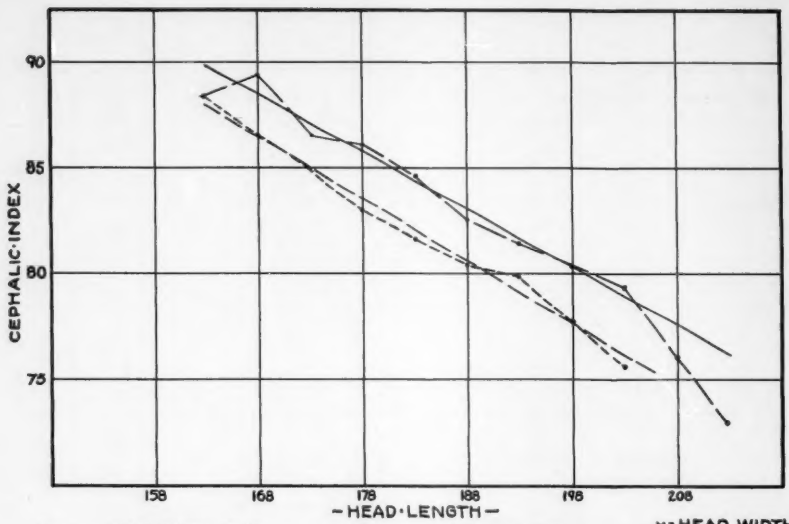

CRANIAL · INDEX
SKULL·LENGTH
— 157 PERUVIAN MALE SKULLS —
(SANKAS, AJPA, 14:309, 1930)



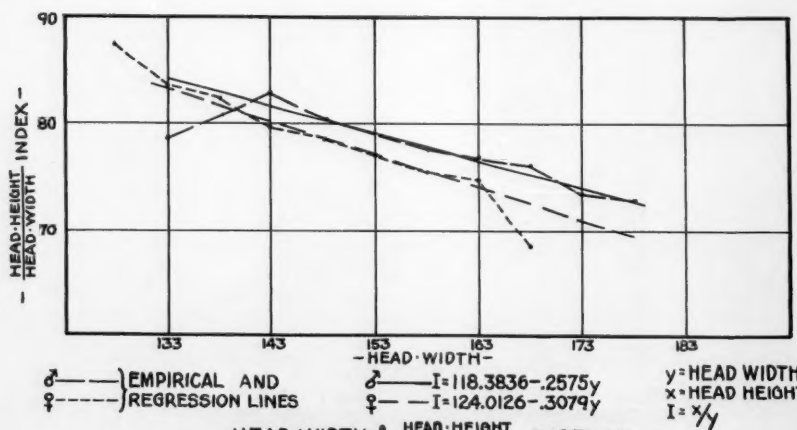
— 242 PERUVIAN FEMALE SKULLS —
(SANKAS, *AJPA*, 14:312-15, 1930)



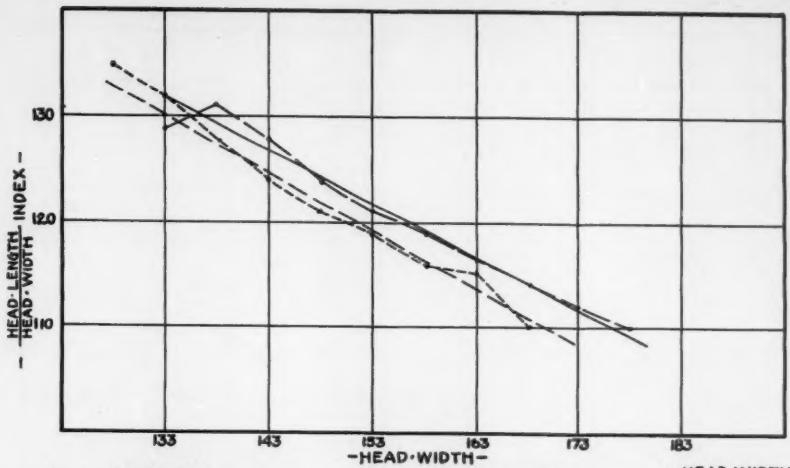
-•- RELATION BETWEEN EAR-LENGTH & EAR-INDEX, 145 PERUVIAN MALES -•-
(FERRIS, AJAM, NO. 3: 106-121, 1916)



HEAD·LENGTH & CEPHALIC·INDEX
••• 1874·MALES, 1487·FEMALES, LIVING·GERMANS •••
(PFITZNER, *Z f M & A*, 5:263, 1903)



HEAD·WIDTH & $\frac{\text{HEAD·HEIGHT}}{\text{HEAD·WIDTH}}$ · INDEX·IN
••• 1735·MALES, 1395·FEMALES, LIVING·GERMANS •••
(PFITZNER, *Z f M & A*, 5:266, 1903)



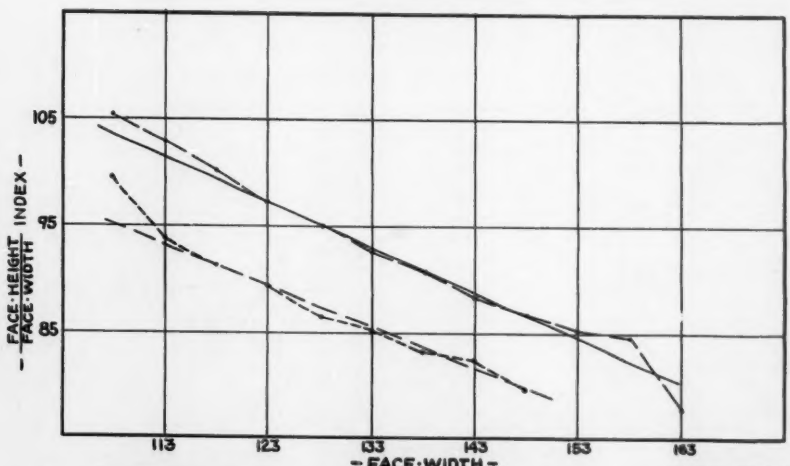
♂——— EMPIRICAL AND ♀----- REGRESSION LINES

♂——— I = 199.08 − .5068x

♀— — I = 198.99 − .5246x

x = HEAD WIDTH
y = HEAD LENGTH
I = Y/x

HEAD·WIDTH & HEAD·LENGTH / HEAD·WIDTH · INDEX · IN
••• 1893·MALES, 1488·FEMALES, LIVING·GERMANS •••
(PFITZNER, *ZfM&A*, 5:264, 1903)



♂——— EMPIRICAL AND ♀----- REGRESSION LINES

♂——— I = 148.3869 − .4177y

♀— — I = 137.2350 − .3911y

y = FACE WIDTH
x = FACE HEIGHT
I = X/y

FACE WIDTH, FACIAL INDEX,
••• 1745·MALES, 1396·FEMALES, LIVING·GERMANS •••
(PFITZNER, *ZfM&A*, 5:267, 1903)

Using Pearson's formula (Proc. Roy. Soc., 60, 489-498, 1897) for deriving the sigma of I, namely

$$\text{Sigma } I = \sqrt{V^2x + V^2y - 2\, r\, XY\, Vx\, Vy}$$

the relations between the r and the eta correlations of head dimensions and indices in living Germans (Pfitzner) are shown in Table B.

TABLE B

No.	Sex	r	eta	Variables correlated
1898	M	-.51	.51	Head length - Breadth / Length
1497	F	-.52	.53	" " "
1898	M	-.57	.57	Head width - Length / Breadth
1497	F	-.57	.60	" " "

Testing shows that r and eta do not differ more than would be expected by chance.

For the series of 242 female Peruvian skulls linear correlation of skull length with cranial index is -.7171. The coefficient of X eta Y is .7209. $\frac{eta^2 - r^2}{1 - r^2}$ is .0113. In a series of 57 Alsatian skulls coefficient of regression of length on cranial index is -3.66 and of cranial index on length is -2.07. Respective values by eta correlation are 4.50 and 2.27.

In a series of 26 Alsatian skulls regression of length on index is -2.18 by r and 2.53 by eta. In Table C (Pfitzner) testing shows that regressions by r and by eta do not differ more than is to be expected by chance.

TABLE C

REGRESSIONS BY r AND BY eta, LIVING GERMANS (PFITZNER)

Variables X	Variables I	No.	Sex	Regression XI r	Regression XI eta	r - eta
Head Breadth	Cephalic Index	1899	M	3.28	3.32	-.04
" "	"	1497	M	3.14	3.31	-.17
Head Length	Cephalic Index	1898	M	-2.12	2.04	.08
"	"	1497	F	-1.96	1.99	-.03
"	"	1874	M	-1.89	1.90	-.01
"	"	1487	F	-1.91	1.92	-.01
Head Breadth	Length / Breadth	1893	M	-3.239	3.278	-.04
"	"	1488	F	-3.009	3.041	-.03
Face Width	Facial Index	1745	M	-3.02	3.03	-.01
"	"	1396	F	-2.59	2.64	-.05
Head Width	Head Height / Head Width	1735	M	-1.66	1.72	-.06
"	"	1395	F	-1.81	1.86	-.05

Regressions are almost uniformly lower by r than by eta, in the above series, but in no case is the difference as great as .2. In view, then, of the close correspondence of r and eta and of the respective regressions, it seems legitimate to analyze the relationship by the shorter r method. The tables which follow give regression coefficients and, where the data permit its computation, either the coefficient of correlation of dimension with index, or relative regression coefficient, or both.

We use the designation k to signify regression coefficient. Ratio of lag is lag of x(100)/lag of.y. Inasmuch as lag is inversely proportional to the quantity r xy(Vx/Vy) or r xy(Vy/Vx), when the values are plus, and directly proportional when they are minus, interpretation of the ratio of lags must take account of the signs.

For convenience of reference we have listed paired dimensions alphabetically under the respective headings of Head and Skull, and Body Proportions, with alphabetic order under Stature, in the latter group.

LAG IN HEAD AND SKULL

TABLE 1

x, Cranial Capacity
y, Cranial Dimension, i, $\frac{y}{x}$

Naqada Crania

y	Male			Female		
	N	r xy	r xi	N	r xy	r xi
Head Length	89	.50	-.91	123	.60	-.90
Head Breadth	89	.43	-.90	123	.53	-.87
Head Height	86	.64	-.86	114	.62	-.85
Horizontal Arc	84	.68	-.96	115	.72	-.96
Vertical Arc	84	.66	-.91	118	.80	-.92

TABLE 2

x, Face Breadth
y, Face Height, i, $\frac{y}{x}$
(Nasion-alveon height except in case of Fecos, Nasion-menton height)

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
LIVING						
North Sweden	M	4795	.15	.09	.24	40
West Sweden	M	13222	.17	.11	.26	42
East Sweden	M	15497	.16	.11	.24	44
South Sweden	M	8714	.19	.12	.29	41
Cities Sweden	M	4755	.16	.10	.25	41
Total Sweden	M	47387	.18	.12	.28	42
Germans	M	1744	--	.19	.33	58
German	F	1404	--	.21		
Aissor	M	32	--	.51		
Tatz	M	14	--	.48	--	
Kazikoumouk	M	11	--	.31	--	
SKULLS						
Fecos	M	86	.22	.21	.23	91
Fecos	F	59	.34	.17	.69	25
Fecos	M	90	.16	.16	.26	67
Fecos	F	61	.27	.14	.62	27
Egyptians	M	700	.28	.17	.46	37
Egyptians	F	400	.33	.21	.52	40
Andaman	M	12	.49	.32	.61	64
Andaman	F	12	.38	.22	.66	33
Tenerife	M	245	.49	.30	.80	38
LIVING						
			Rx	Ri	r xi	
Norway 18 groups Norway	M		-.301	-1.86x	-.74	
14 groups	M		-.291	- .85x	-.27	
Peruvian Indians	M	144	-.101	- .04x	-.07	
Peruvian Indians 7 groups	M	--	--	.25x	.33	
Negro	M	20	-.691	- .46x	-.56	
SKULLS						
Sardinians	M	10	-.671	- .58x	-.62	
Naqada	M	77	--	--	-.47	
Naqada	F	101	--	--	-.24	
Egyptians	M	700	--	--	-.32	
Egyptians	F	400	--	--	-.31	
Sediments, Egyptian	M	36	-.155i	- .01x	-.02	
Egyptian	F	29	-.021	- .02x	-.02	

x, Face Breadth
y, Facial Index

SKULLS					
			Rx	Ri	r xi
Batavia, Java	M	30	-.86	- .73	-.63

x, Face Breadth
y (i), Total Facial Index

LIVING					
English Ordinary Criminals	M	100	.41	.54	.48
English Lunatic Criminals	M	30	.27	.70	.84

TABLE 2A

x, Ear Length
y, Ear Width

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
LIVING, Means						
Germans, Balkans	M	7	.74	.84	.65	129
Laze, Black Sea	M	15	.34	.46	.25	136
Greeks	M	13	.68	.51	.91	56
Albanians	M	11	.88	.97	.79	123
Serbs	M	11	.62	.57	.69	83
Jews, Balkans	M	6	.71	.91	.54	87
Gypsies, Balkans	M	6	.84	.76	.92	83
Osmanli Turks	M	20	.38	.24	.65	37
Bulgarians	M	20	.64	.88	.69	41
Balkans	M	14	.32	.37	.27	137
Roumanians	M	18	.46	.61	.35	174
Tatars	M	22	.41	.38	.44	89
Eskimo	M	7	.52	.55	.49	112

TABLE 3

x, Face Breadth
y, Bijugal Diameter

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio in Lags
LIVING, Means						
Serbs	M	11	.86	.93	.80	116
x, Face Breadth y, Total Face Length						
LIVING, Means						
Chinese, Turkestan Pamirs	M	25	.27	.68	.11	618
x, Face Breadth y, Ophryon-Menton						
LIVING, Means						
Balkans	M	13	.74	.75	.72	104
Osmanli Turks	M	20	.52	.32	.84	38
Tatars	M	22	.57	.28	1.18	24
Greeks	M	13	.66	.40	1.09	37
Jews, Balkans	M	6	.55	.51	.60	85
Gypsies, Balkans	M	6	.86	.40	1.84	22
Armenians	M	12	.82	.72	.94	77
Germans, Balkans	M	7	.46	.19	1.13	17
Bulgarians	M	20	.69	.43	1.09	39
x, Face Breadth y, Upper Face Length						
LIVING, Means						
Chinese, Turkestan Pamirs	M	25	-.07	-.17	-.03	567
x, Face Breadth y, Upper Facial Index						
SKULLS						
			r xy	Rx	Ri	
Batavia, Java	M	14	-.06	-.49	-.56	
Spitalfields	M	28	-.58	-.76	-.44	
x, Face Breadth y, Minimum Frontal Breadth						
Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio in Lags
LIVING						
North Sweden	M	4795	.50	.45	.56	81
West Sweden	M	13222	.62	.44	.81	72
East Sweden	M	15497	.62	.44	.81	72
South Sweden	M	8714	.53	.46	.62	74
Swedish Cities	M	4755	.54	.46	.64	72
All Swedish Groups	M	47387	.53	.46	.62	74
SKULLS						
Egyptians	M	700	.42	.35	.50	70
Egyptians	F	400	.49	.43	.55	78
Tenerife	M	245	.44	.35	.55	64
Greifenberg	M	219	.46	.61	.41	124
Merovingian	M	72	.34	.36	.32	112
Merovingian	F	34	.19	.26	.14	186
x, Face Length y, Upper Face Length						
LIVING						
Chinese, Turkestan, Pamirs	M	25	.52	.50	.54	93

TABLE 4

x, Face Breadth
y, Head Breadth, i, $\frac{y}{x}$
M, Negro; I, Indian; W, White

LIVING					
English Criminals	M	3000	.62	.56	.69	81
U. S. Negro	M	106	.45	.40	.50	80
M (I)	M	36	.77	.65	1.08	52
MW	M	189	.62	.53	.73	73
MW (I)	M	51	.65	.57	.75	106
W	M	99	.52	.38	.71	54
W (I)	M	57	.70	.62	.80	78
SKULLS						
Egyptians	M	700	.37	.39	.36	108
Egyptians	F	400	.44	.37	.51	119
Greifenberg	M	219	.60	.65	.56	116
Merovingian	M	72	.54	.60	.48	125
Merovingian	F	34	.48	.35	.16	53
Tenerife	M	245	.52	.61	.44	140
			Rx	Ri	r xi	
Egyptians	M	400	--	--	-.58	
Egyptians	F	700	--	--	-.62	
Peruvians, 7 group	M		--	.11x	.33	
Eskimo, 19 groups	M		.62i	.76x	.40	
Eskimo, 17 groups Roumanians,	F		.47i	.85x	.34	
18 groups	M		.62	.85	.32	
English Criminals	M	3000	--	--	-.54	

LAG IN HEAD AND SKULL

TABLE 5

x, Face Breadth 1, $\frac{y}{x}$
y, Nose Breadth

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio 1a Lags
SKULLS						
Egyptian	M	700	.25	.12	.51	24
Egyptian	F	400	.23	.12	.45	27
Merovingian	M	162	.11	.05	.21	24
Pecos	M	101	.10	.06	.16	38
African tribes, means	M	13	.78	.45	1.34	34
			kx	k1	r 21	
Egyptians	M	700	---	---	-.28	
Egyptians	F	400	---	---	-.28	
French	?	46	.40x	.06x	.16	
Hungarian		20	-.131	-.02x	-.04	
Slave		31	.541	.03x	.12	
Chinese, Peking		25	-.191	-.06x	-.11	
Chinese, Formosa		25	.811	.18x	.38	
Negro, West Africa		28	1.251	.28x	.51	
Negro, East Africa		15	.681	.14x	.31	
Egyptians, Ancient		50	-.121	-.01x	-.04	
Peruvians		31	-2.271	-.10x	-.48	
New Pomerania		15	2.061	.11x	.49	
Banning		15	.431	.13x	.24	
Javanese		12	-.851	-.10x	-.30	

	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio 1a Lags
x, Face Breadth y, Biorbital Breadth						
LIVING						
Roumanians, Means	M	16	.54	.46	.63	73
x, Facial Breadth y, Orbital Width, Right						
SKULLS						
Batavia, Java	M	32	.40	.42	.37	114
Batavia, Java	M	15	.38	.65	.22	295

TABLE 5A

x, Foramen Magnum Length
y, Foramen Index

			r xy	kx	k1	
SKULLS						
Spitalfields	F	54	-.36	-.14	-.96	
Spitalfields	F	8	.15	.11	.20	
Spitalfields	M	30	-.39	-.17	-.90	
Spitalfields	M	11	-.60	-.15	-2.52	
Spitalfields	F	7	-.85	-.20	-3.61	
Spitalfields	M	12	-.08	-.07	-.08	
Spitalfields	M	21	-.61	-.26	-1.46	
Spitalfields	M	57	-.42	-.18	-.99	
Spitalfields	M	89	-.69	-.43	-1.12	

TABLE 6

x, Head Height
y, Face Height

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio 1a Lags
SKULLS						
Tenerife	M	845	.25	.14	.46	30
Egyptian	M	700	.18	.12	.29	41
Egyptian	F	400	.16	.11	.31	35
Merovingian	M	76	.26	.19	.36	53
Gallo-Roman	M	108	.10	.07	.13	54
Gallo-Roman	M	118	.18	.11	.30	37
Greifenberg	M	226	.28	.19	.44	43
32 Ethnic Groups	M & F		.07	.05	.12	42
x, Height y, Face Breadth						
Tenerife	M	845	.13	.21	.26	81
Egyptian	M	700	.25	.25	.22	114
Egyptian	F	400	.28	.26	.30	87
41 Ethnic Groups	M & F		.09	.09	.08	112
x, Head Height y, Minimum Frontal Breadth						
Pecos Indian, Normal	M	74	.69	.50	.96	52
Pecos Indian, Deformed	M	25	.53	.45	.47	95
Andaman	M	12	.83	.15	.36	42
Andaman	F	12	-.14	-.11	-.18	61
38 Ethnic Groups	M & F		-.14	-.17	-.11	155
x, Head Length y, Minimum Frontal Breadth						
Tenerife	M	845	.40	.22	.71	31
Pecos, Normal	M	41	.36	.25	.52	48
Pecos, Deformed	M	25	.23	.23	.23	100
Andaman	M	12	.45	.22	.96	23
Andaman	F	12	-.46	-.42	-.50	84
Greifenberg	M	219	.02	.20	.25	80
38 Ethnic Groups	M & F		.32	.33	.31	106
x, Head Breadth y, Face Height						
Tenerife	M	845	.45	.24	.67	36
Egyptian	M	700	.14	.08	.25	32
Egyptian	F	400	.19	.11	.32	34
32 Ethnic Groups	M & F		.50	.45	.56	80

TABLE 6
(Cont.)

x, Face Breadth
y, Orbit Breadth

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio 1a Lags
SKULLS						
Pecos Indian	M	98	.60	.58	.62	93
Merovingian	M	162	.20	.15	.26	58
x, Face Height y, Nose Height						
Pecos Indian	M	110	.67	.66	.66	100
Merovingian	M	213	.68	.67	.70	96
Egyptian	M	700	.71	.74	.68	109
Egyptian	F	400	.71	.75	.66	114
x, Face Height y, Orbit Height						
Pecos Indian	M	103	.49	.57	.42	136
Merovingian	M	213	.45	.44	.46	96
x, Face Breadth y, Bigonial Breadth						
Pecos Indian	M	79	.55	.55	.57	96
Merovingian	M	72	.57	.63	.51	83
Merovingian	F	54	.37	.20	.69	29
x, Face Height y, Skull Base (Basion-Alveon)						
Pecos Indian	M	89	.30	.44	.20	220
Egyptian	M	700	.17	.31	.06	179
Egyptian	F	400	.14	.23	.06	157
31 Ethnic Groups	M & F		.12	.20	.06	250
x, Face Breadth y, Skull Base						
Pecos Indian	M	79	.27	.32	.22	146
40 Ethnic Groups	M & F		.20	.24	.17	89

TABLE 7

x, Head Length
y, Face Height

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio 1a Lags
SKULLS						
Egyptian	M	700	.26	.14	.50	28
Egyptian	F	400	.29	.14	.62	23
Merovingian	M	76	.27	.14	.52	27
Merovingian	F	54	-.32	-.18	-.56	32
Greifenberg	M	226	.22	.14	.34	41
Tenerife	M	845	.48	.20	1.10	18
x, Head Length y, Face Breadth						
Egyptian	M	700	.38	.33	.44	75
Egyptian	F	400	.51	.22	.42	52
Merovingian	M	167	.19	.14	.22	64
Greifenberg	M	219	.16	.17	.15	114
Tenerife	M	845	.55	.38	.78	49
41 Ethnic Groups	M & F		.45	.42	.47	89
English Criminals*	M	3000	.40	.35	.46	76

*Living

TABLE 8

x, Foramen Magnum Length
y, Various Measures

			r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio 1a Lags
SKULLS			x, Palate Length			
Nylam Chinese	M	39	.11	.09	.14	64
East Asiatic, 12 Groups	M		.87	.96	.78	123
			x, Skull Length			
Europeans, 6 Groups	M		-.11	-.80	-.06	33
			x, Nose Height			
Easter Island	M	36	-.54	-.54	-.53	102

			r x1	
1, $\frac{\text{Foramen Breadth}}{x}$				
English	M	33	-.48	
English	F	21	-.45	
Europeans, 5 Groups	M		-.86	
Europeans, 6 Groups	M		-.79	
Sudarian	M	56	-.59	
Easter Island	M	55	-.82	
Easter Island	F	16	-.75	
Nylam Chinese	M	39	-.84	
Java, 6 Groups	M		-.40	
East Asiatic, 13 Groups	M		-.42	

TABLE 9

x, Head Breadth
1, Cephalic Index

			kx	k1	r x1
LIVING					
New Guinea	M	220	.721	.56x	.63
French	M	860	---	.51x	.70
French	F	340	---	.60x	.73
Nagada	M	130	---	.34x	.49
Nagada	F	169	---	.48x	.70
English	M	131			.68
English	M	130			.60

97102B

LAG IN HEAD AND SKULL

TABLE 10

x, Head Length
i, Cephalic Index

Group	Sex	N	kx	ki	r xi
LIVING					
Swedish, 25 Groups	M		-1.011	-.51x	-.72
Danish	M	28	-0.91	-.11x	-.10
German	M	1898	--	--	-.61
German	F	1497	--	--	-.62
Cambridge Students	M	1000	--	--	-.55
English Criminals	M	3000	--	--	-.61
English	M	1306	--	--	-.69
Finn, Kartlie	M	28	-1.181	-.43x	-.71
Finn. Tavastlande	M	26	-0.811	-.33x	-.62
Finn. Tavastlande	F	31	-0.731	-.17x	-.35
Turk, 7 Groups	M & F		-1.201	-.64x	-.87
Transjordania, 20 Groups	M		-1.531	-.43x	-.82
Alsaors	M	22	0.171	.17x	.15
Kaitkoumouks	M	11	-0.841	-.57x	-.52
Tadjak	M	14	-0.181	-.05x	-.09
Coohin-China	M	21	-0.691	-.49x	-.57
Cambodian	M	11	-0.971	-.50x	-.70
Tonkinese	M	21	-1.111	-.59x	-.66
Peruvian, Piro	M	23	-1.971	-.10x	-.44
Peruvian, Machuyenga	M	19	-2.431	-.95x	-.92
Peruvian, Lipibo	M	14	-0.701	-.39x	-.52
Peruvian	M	145	-1.141	-.32x	-.90
Chootaw	M	31	-1.711	-.32x	-.74
Chootaw	F	17	-1.921	-.54x	-.80
Eskimo, 24 Groups	M		-0.841	-.58x	-.70
Negro, U. S.	M	20	-0.971	-.38x	-.82

TABLE 11

x, Head Length
i, Cephalic Index

SKULLS	Sex	N	kx	ki	r xi
Marne, Neolithic	M	19	-1.301	-.52x	-.82
Marne, Neolithic	F	18	-1.111	-.41x	-.68
Gaule, Ancient	M	36	-0.511	-1.27x	-.80
Gaule, Ancient	F	25	-0.451	-1.05x	-.68
French	M	17	-0.501	-0.26x	-.36
French	M	6860	--	--	-.55
French	F	380	--	--	-.72
French, Saône-et-Loire	M	14	-1.391	-0.34x	-.69
French Murderers	M	24	-0.521	-0.22x	-.34
Basque	M	23	-0.871	-0.18x	-.40
Basque	F	18	-0.671	-0.36x	-.49
Basque	F	15	-1.291	-0.28x	-.60
Basque	M	16	-1.971	-0.15x	-.54
Alsatians	?	27	--	-0.20x	--
Alsatians	M	57	--	-0.44x	--
Alsatians	F	54	--	-0.42x	--
Tenerife	M	72	-1.751	-0.16x	-.52
Tenerife	M	18	-0.821	-0.03x	-.16
Sardinian	M	11	-1.621	-0.39x	-.80
Italian	M	14	--	-0.15x	--
English	M	131	--	--	-.55
English	F	130	--	--	-.56
British Long Barrows	M	25	-0.228	-0.91x	-.34
British Long Barrows	M	20	-0.381	-0.50x	-.44
British Round Barrows	M	25	-0.351	-0.65x	-.47
British Chambered Long Barrows	M	35	-0.701	-0.77x	-.73
British Chambered Long Barrows	F	21	-0.501	-1.18x	-.76
Finn, Helsinfors	M	41	-1.261	-0.38x	-.65
Finn, Helsinfors	F	31	-0.641	-0.89x	-.43
Baden	M	11	--	-0.82x	--
Baden	F	12	--	-0.30x	--
Galician	?	17	-0.981	-0.51x	-.56
Lothringen	M	15	--	-0.61x	--
Russian, Kourganes	?	14	-1.191	-0.28x	-.53
Egyptian	M	48	-1.711	-0.34x	-.65
Egyptian	F	42	-1.221	-0.42x	-.72
Egyptian	M	700	--	--	-.46
Egyptian	F	400	--	--	-.48
Egyptian, Naqada	M	130	--	-0.27x	-.55
Egyptian, Naqada	F	169	--	-0.31x	-.56
Egyptian, Naqada	M	139	--	--	-.55
Egyptian, Naqada	F	183	--	--	-.51
Indians, Ohio	F	26	-0.911	-0.66x	-.77
Indians, Peru	M	157	-1.001	-.56x	-.75
Indians, Peru	F	262	-0.931	-.59x	-.76
Indians, Peru	M	32	-1.161	-.51x	-.62
Negro, Kamerun	M	13	--	-.46x	--

TABLE 12

x, Head Length
y, Head Breadth, i, $\frac{y}{x}$

Group	Sex	N	r xy	r xi	r xy (Vx/Vy)	r y (Vy/Vx)	Ratio in Lags
LIVING							
Egyptians (26 yrs or over)							
Province A	M	384	.21	-.55	.18	.24	75
Province B	M	504	.21	-.65	.21	.21	100
Province C	M	526	.21	-.59	.19	.23	83
Province D	M	491	.23	-.58	.20	.25	80
Province E	M	610	.23	-.61	.23	.23	100
Province F	M	317	.23	-.61	.23	.23	100
Province G	M	643	.26	-.27	.22	.28	85
Province H	M	802	.26	-.49	.23	.25	92
Province I	M	515	.25	-.69	.24	.26	92
Province J	M	262	.24	-.61	.22	.30	73
Province K	M	326	.24	-.61	.25	.30	83
Province L	M	824	.27	-.56	.27	.31	87
Province M	M	295	.30	-.65	.28	.33	85
Province N	M	887	.31	-.68	.30	.32	94
Province O	M	1104	.32	-.64	.30	.34	88
Province P	M	187	.32	-.43	.26	.42	62
Province Q	M	413	.37	-.50	.33	.41	80

TABLE 13

x, Head Length
y, Head Breadth

Group	Sex	N	r xy	r y (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
LIVING						
English Criminals	M	3000	.40	.36	.42	90
Cambridge Students	M	1000	.34	.33	.36	92
Aberdeen, Normal	M	787	.42	.39	.45	86
Aberdeen, Insane	M	297	.39	.38	.40	96
Banff, Normal	M	105	.45	.43	.47	93
Banff, Insane	M	84	.39	.36	.41	88
Scottish Soldiers	M	2687	.36	.35	.38	92
Scottish, Insane	M	4381	.46	.46	.51	89
Germans	M	1898	--	--	.51	--
Germans	F	1497	--	--	.51	--
North Sweden	M	4795	.25	.23	.27	85
West Sweden	M	13222	.28	.27	.29	92
East Sweden	M	15497	.26	.25	.27	92
South Sweden	M	8714	.32	.29	.35	83
Cities, Sweden	M	4795	.28	.26	.30	88
All Swedish	M	47387	.27	.25	.29	88
SKULLS						
Greifenberg	M	219	.07	.07	.07	114
Tenerife	M	285	.59	.49	.71	69
Pecos, deformed	M	91	-.13	-.16	-.11	148
Pecos, deformed	F	68	-.30	-.41	-.22	186
Pecos, normal	M	43	.09	.09	.09	100
Pecos, normal	F	25	-.52	-.42	-.63	67
Andaman	M	12	-.31	-.28	-.35	78
Andaman	F	12	.34	.46	.26	173
Egyptian	M	700	.40	.36	.44	82
Egyptian	F	400	.38	.30	.47	64
43 Ethnic Groups			.52	-.18	.58	31
English, Moorfields	F	57	.62	.53	.72	73
English, Whitechapel	F	130	.35	.34	.36	95

TABLE 14

x, Head Length, i, $\frac{y}{x}$
y, Head Breadth, Worchester, Massachusetts

Age Groups	N	r xy	r xi	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
BOYS						
6 Years	105	.30	-.61	.31	.29	107
7	142	.18	-.68	.20	.16	125
8	120	.14	-.62	.13	.15	87
9	167	.29	-.63	.31	.27	115
10	157	.17	-.62	.16	.18	89
11	151	.12	-.65	.12	.11	92
12	177	.30	-.50	.26	.35	74
13	168	.15	-.68	.16	.14	114
14	164	.24	-.60	.26	.22	118
15	158	.14	-.68	.15	.13	115
16	96	.28	-.62	.28	.27	107
17	49	.18	-.62	.17	.19	89
GIRLS						
6 Years	84	.30	-.62	.31	.29	107
7	101	.09	-.73	.10	.08	125
8	105	.16	-.69	.18	.15	120
9	118	.30	-.61	.31	.29	107
10	160	.25	-.63	.26	.24	108
11	152	.29	-.53	.26	.33	79
12	165	.24	-.67	.22	.26	85
13	148	.32	-.65	.35	.29	121
14	115	.59	-.52	.57	.61	93
15	109	.26	-.66	.24	.29	83
16	91	.43	-.48	.40	.47	85
17	69	.29	-.60	.29	.29	100

TABLE 15

x, Head Breadth
y, Head Height

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio in Lags
LIVING						
Aberdeen, Normal	M	787	.32	.34	.43	56
Aberdeen, Insane	M	297	.40	.34	.46	72
Banff, Normal	M	105	.36	.31	.42	73
Banff, Insane	M	84	.47	.36	.60	60
Scottish Soldiers	M	2687	.30	.25	.35	71
Scottish, Insane	M	4381	.35	.31	.40	78
Germans	M	1715	--	.22	.43	52
Germans	F	1396	--	.20	.37	54
U. S. Negro	M	108	.42	.46	.38	121
N (I)*	M	36	.29	.30	.28	107
NHW*	M	129	.28	.34	.23	148
NHW (I)*	M	51	.08	.03	.01	300
HW*	M	25	.26	.28	.24	117
HW (I)*	M	57	.07	.07	.06	117
SKULLS						
43 Ethnic Groups	M & F		-.13	-.19	-.09	211
Whitechapel	F	115	.34	.30	.38	79
Moorfields	F	44	.29	.29	.29	101
Tenerife	M	245	.30	.28	.32	87
Pecos, Normal	M	33	.42	.40	.45	89
Pecos, Normal	F	21	.31	.40	.28	214
Pecos, Deformed	F	53	.34	.45	.26	173
Pecos, Deformed	M	78	.35	.28	.22	127
Egyptian[2]	M	700	.33	.31	.36	86
Egyptian[2]	F	400	.34	.30	.34	97
Egyptian[3]	M	700	.46	.45	.48	90
Egyptian[3]	F	400	.41	.41	.41	100
Andaman	M	12	-.03	-.02	-.04	50
Andaman	F	12	.29	-.27	.32	84

*M, Negro
I, Indian
W, White

2, Basio-Bregmatic Height - 3, Auricular Height

LAG IN HEAD AND SKULL

TABLE 16

x, Head Breadth
y, Minimum Frontal Breadth, i. $\frac{y}{x}$

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
SKULLS						
Egyptians	M	700	.33	.26	.41	63
Egyptians	F	400	.29	.24	.36	67
38 Ethnic Groups	M & F		.33	.50	.22	227
Tenerife	M	245	.46	.31	.68	46
Merovingian	M	72	.34	.41	.29	141
Merovingian	F	54	.26	.26	.26	100
Pecos, normal	M	59	.48	.32	.72	44
Pecos, deformed	M	82	.38	.31	.45	69
Andaman	M	12	-.09	-.05	-.16	31
Andaman	F	12	0	0	0	--
			kx	ki	r xi	
Ainu	?	30	-.401	-.18x	-.26	
Davos	?	14	-.671	-.18x	-.35	
Alsatian	M	20	-.511	-.19x	-.31	
Alsatian	F	16	-1.061	-.37x	-.63	
Japanese	?	17	-.581	-.21x	-.35	
Negro	?	13	-.101	-.05x	-.07	
Egyptians	?	20	-.631	-.44x	-.53	
Australian	M	21	-.801	-.35x	-.53	
Australian	F	15	-.781	-.25x	-.44	
Australian (¾ mixture)	?	15	-.861	-.24x	-.39	
Huron, Iroquois	?	12	-.401	-.03x	-.12	
Egyptians	M	700	--	--	-.45	
Egyptians	F	400	--	--	-.48	

TABLE 17

x, Head Length
y, Head Height

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
LIVING						
Aberdeen, normal	M	787	.34	.27	.48	48
Aberdeen, insane	M	297	.35	.29	.42	70
Banff, normal	M	106	.19	.15	.23	68
Banff, insane	M	84	.42	.31	.58	53
Scottish Soldiers	M	2687	.34	.27	.42	65
Scottish, insane	M	4381	.38	.31	.46	67
Germans	M	1732	--	.13	.32	41
Germans	F	1397	--	.17	.40	42
Choctaw	M	31	--	--	.54	--
Choctaw	F	17	--	--	.62	--
U. S. Negro	M	102	.37	.39	.35	111
*N(I)	M	33	.89	.86	.92	81
NNW	M	118	.38	.39	.37	105
NNW (I)	M	44	.33	.43	.25	172
NW	M	87	.85	.87	.83	117
NW (I)	M	45	.52	.46	.58	79

*N. Negro - I, Indian - W, White

SKULLS						
41 Ethnic Groups	M & F		.62	.48	.78	62
*Egyptians	M	700	.38	.32	.46	70
*Egyptians	F	400	.19	.15	.24	62
**Egyptians	M	700	.39	.34	.47	72
**Egyptians	F	400	.32	.25	.39	64
Andaman	M	12	.02	.02	.03	67
Andaman	F	12	.32	.39	.26	150
Tenerife	M	245	.52	.40	.67	60
Pecos, normal	M	59	.42	.41	.43	95
Pecos, normal	F	81	.25	.31	.21	148
Pecos, deformed	M	80	.15	.16	.10	160
Pecos, deformed	F	55	.31	.43	.22	196
Moorfields	F	44	.26	.21	.28	74
Whitechapel	F	120	.42	.37	.49	76

*Basic-Prismatic - **Auricular

TABLE 18

x, Head Length
y, Head Height i. $\frac{y}{x}$
Auricular Height

Group	Sex	N	kx	ki	r xi
SKULLS					
Gauls, Ancient	M	26	-.481	-.90x	-.65
Gauls, Ancient	F	21	-.661	-.48x	-.56
Long Barrows, Falsten & Moën	--	17	-.851	-.55x	-.37
British Long Barrows	M	23	-.451	-1.13x	-.71
British Round Barrows	M	24	-.251	.46x	-.14
British Chambered Barrows	M	33	-.911	-.63x	-.75
British Chambered Barrows	F	16	-.231	-1.17	-.52
Alsatians	?	23	--	.04x	--
Galicians	?	10	-1.251	-.80x	-.50
Egyptians	M	700	--	--	-.46
Egyptians	F	400	--	--	-.46
LIVING					
Choctaw	M	31	-.631	-.44x	-.17
Choctaw	F	17	--	--	-.78
Basic-Prismatic Height					
SKULLS					
Naqada	M	133	--	-.16x	-.33
Naqada	F	166	--	-.27x	-.51
Egyptian	M	700	--	--	-.43
Egyptian	F	400	--	--	-.52
English	M	180	--	--	-.48
English	F	117	--	--	-.48

TABLE 19

x, Horizontal Circumference
y, Head Length

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio in Lags
LIVING						
Oxford Students, 18 years	M	129	.63	.61	1.12	55
Oxford Students, 19 years	M	330	.80	.64	1.00	64
Oxford Students, 20 years	M	209	.86	.70	1.06	66
Oxford Students, 21 years	M	137	.86	.70	1.05	67
Oxford Students, 22 years	M	95	.80	.68	.94	72
Germans	M	1721	--	--	.88	--
Germans	F	1389	--	--	.76	--
SKULLS						
Greifenberg	M	219	.81	.54	1.22	44
Egyptians	M	700	.88	.76	1.03	74
Egyptians	F	400	.87	.76	.98	78

x, Horizontal Circumference
y, Head Breadth

LIVING						
Germans	M	1721	--	--	.85	--
Germans	F	1389	--	--	.76	--
SKULLS						
Greifenberg	M	219	.55	.39	.78	49
Egyptian	M	700	.63	.49	.82	60
Egyptian	F	400	.66	.47	.96	50

x, Horizontal Circumference
y, Transverse Arc

Egyptians	M	700	.52	.49	.71	69
Egyptians	F	400	.52	.48	.65	74
Pecos Indian, normal	M	35	.60	.34	.65	52
Pecos Indian, normal	F	86	.64	.51	.65	78
Pecos Indian, deform	M	89	.25	.20	.32	62

x, Horizontal Circumference
y, Sagittal Arc

Egyptians	M	700	.75	.60	.96	62
Egyptians	F	400	.68	.55	.86	64
Pecos Indian, normal	M	32	.70	.45	1.06	43
Pecos Indian, normal	F	84	.79	.62	1.01	62
Pecos Indian, deform	M	81	.81	.69	.94	73

x, Transverse Arc
y, Sagittal Arc

Egyptians	M	700	.65	.62	.69	90
Egyptians	F	400	.59	.59	.59	100
Pecos Indian, normal	M	32	.28	.24	.32	75
Pecos Indian, deform	M	82	.30	.33	.27	122

TABLE 20

x, Nasal Height
y, Nasal Breadth i. $\frac{y}{x}$

SKULLS						
Egyptians	M	700	.24	.19	.31	61
Egyptians	F	400	.20	.16	.27	59
Pecos Indian	M	128	-.09	-.06	-.13	46
Pecos Indian	F	86	.18	.12	.29	41
			kx	ki	r xi	
Hungarians		20	-.891	-.67x	-.44	
Slavs		31	-.901	-.70x	-.49	
French		66	-.971	-.99x	-.49	
Basques	M	23	-.161	.24x	-.20	
Basques	M	14	.111	.21x	.15	
Basques	F	16	-.311	-.40x	-.37	
Basques	F	15	-.691	-.95x	-.77	
Sardinians	M	11	-.941	-.70x	-.55	
Kourganes, Russia		14	-.161	-.29x	-.21	
Anglo-Saxons	M	19	-.171	.31x	.23	
Anglo-Saxons	F	19	-.471	-.58x	-.42	
Early Mediterranean						
Means of 7 Groups	M		-.271	-.46x	-.35	
Means of 7 Groups	F		-.581	-1.54x	-.99	
Predynastic Egyptian						
Means of 10 Groups	M		-.721	-.19x	-.37	
Egyptian, after 5th Dynasty						
Means of 6 Groups	M		-.901	-.25x	-.48	
Middle & Late Predynastic Egyptians						
Means of 8 Groups	M		.671	.45x	.55	
Egyptians & Others						
Means of 7 Groups	M		-.261	-2.34x	-.78	
Means of 6 Groups	F		-.001	-.18x	-.01	
Ancient Egypt	M	31	-.921	-1.44x	-.89	
Ancient Egypt	F	10	-.791	-.67x	-.58	
Ancient Egypt	F	85	-.101	-.40x	-.30	
Thebes		90	-.141	-.96x	-.88	
Naqada	M	94	--	--	-.71	
Naqada	F	116	--	--	-.69	
Negroes, Kenya	M	41	--	--	-.72	
Negroes, East Africa	M	15	-.831	-1.38x	-.77	
Negroes, Cameroun & Sudan	M	20	-.811	-.95x	-.45	

LAG IN HEAD AND SKULL

TABLE 20 (Cont.)

x, Nasal Height
y, Nasal Breadth, i, $\frac{y}{x}$

Group	Sex	N	kx	ki	r xi
SKULLS					
Indians, Peru		30	-.754	-.68x	-.71
Indians, Peru	M	61	--	-.77x	--
Indians, Peru	F	46	--	-1.13x	--
Indians, Ohio	M	33	-.281	-.87x	-.50
Indians, Ohio	F	80	-.401	-1.80x	-.89
Indian, Algonkin and Iroquois					
Mean of 5 groups	M & F		-.051	-.11x	-.08
Andaman	M	12	-.281	-.46x	-.35
Andaman	F	12	-.081	-.14x	-.10
Easter Island	M	42	--	--	-.02
Easter Island	F	19	-.391	1.01	-.63
Australian,					
Means of 6 Groups	M		-.011	-.01x	-.01
16 Ethnic Groups	M		-.301	-2.43x	-.86
13 Ethnic Groups	F		-.351	-2.18x	-.87
New Pomerania		15	.441	-1.62x	-.84
Javanese		12	.411	-1.05x	-.86
Chinese, Peking		25	.651	-.90x	-.77
Chinese, Formosa		26	.701	-.32x	-.52
Baining		14	.221	-.68x	-.39
LIVING					
Alsace Armenia	M	22	-.421	-.91x	-.62
Tate (Tadjik) Caucasus	M	14	-.301	-.94x	-.57
Kazikoumouks, Caucasus	M	11	-.281	-1.83x	-.72
Cambodians	M	11	-.391	-1.93x	-.88
Cochin, Chinese	M	21	-.241	-2.14x	-.72
Tokinese	M	21	-.091	-.30x	-.16
Negroes, American	M	19	-.271	-2.31x	-.79
Indians, Piro	M	23	-.331	-.49x	-.40
Indians, Sipiba	M	14	-.141	-2.32x	-.57
Indians, Anawak	M	19	0	-.13x	-.05
Indians, Peru		149	-.131	-.80x	-.32
Indians, Peru					
Means of 7 Groups	M & F		-.201	-1.72x	-.58

TABLE 21
Lag in Traits of American Negroes and Hybrid Males
(Herskovits, 1930)

x, Nose Breadth
y, Inter-pupillary Distance
N, Negro - W, White - I, Indian

Group	N	r xy	r xi	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Lags
LIVING						
N	108	.10	-.51	.14	.07	200
N (I)	36	.31	-.27	.53	.18	294
NWW	125	.17	-.31	.55	.85	280
NWW (I)	51	.45	-.10	.84	.27	336
NW	93	.31	-.26	.46	.21	219
NW (I)	46	.23	-.27	.46	.11	418
NW + NWW (I)	60	.02	-.43	.004	.01	400
x, Nose Breadth y, Thickness of Lips						
N	109	.22	-.15	.08	.59	14
N (I)	36	.37	-.13	.18	.76	24
NWW	129	.06	-.17	.11	.60	18
NWW (I)	51	.29	-.14	.42	.52	52
NW	95	.33	-.09	.14	.79	18
NW (I)	57	-.08	-.53	-.04	-.15	27
NW + NWW (I)	61	.37	-.22	.21	.64	33
x, Nose Breadth y, Ear Height						
N	108	.16	-.72	.14	.19	74
N (I)	36	.14	-.60	.16	.12	133
NWW	129	.42	-.32	.34	.53	153
NWW (I)	51	.12	-.42	.21	.07	300
NW	94	-.10	-.68	-.12	-.08	150
NW (I)	57	.20	-.31	.34	.10	340
NW + NWW (I)	61	.22	-.31	.41	.12	342
x, Ear Height y, Thickness of Lips						
N	108	.08	-.34	.04	.02	200
N (I)	36	.41	-.03	.14	.43	19
NWW	129	-.14	-.45	-.05	-.20	12
NWW (I)	51	.08	-.32	.03	.02	150
NW	94	-.02	-.55	-.01	-.01	100
NW (I)	57	.29	.00	.08	1.00	8
NW NWW (I)	61	.13	-.18	.04	.42	10

TABLE 22

x, Biorbital Breadth
y, Interorbital Breadth

Group	Sex	N	r xy	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Lags
LIVING, Means of Groups						
Jews, Balkans	M	9	.06	.03	.15	20
Gypsies, Balkans	M	8	.78	.55	.80	81
Albanians	M	11	.42	.20	.09	222
Germans, Balkans	M	7	.82	.51	1.29	42
Balkans	M	14	.14	.78	.27	289
Serbs	M	11	.75	.60	.94	64
Tatars	M	22	.49	.32	.26	123
Slovaks	M	13	.82	.32	.85	38
Bulgarians	M	20	.64	.42	.75	56
Roumanians	M	18	.30	.20	.43	46
Laze, Black Sea	M	15	.19	.23	.05	22
Osmanli Turks	M	20	.63	.34	.47	72

TABLE 22 (Cont.)

x, Orbital Breadth
y, Orbital Height i, $\frac{y}{x}$

Group	Sex	N	r xy	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Lags
SKULLS						
Egyptians	M	700	.26	.19	.36	53
Egyptians	F	400	.32	.24	.32	61
Pecos Indians	M	120	.36	.36	.36	100
Pecos Indians	F	83	.33	.29	.38	76
Whites	M	50	.30	.19	.47	40
Whites	F	43	.56	.39	.80	49
			kx	ki	r xi	
Basques	M	23	-.101	-.49x	-.22	
Basques	M	14	-.001	-.00x	-.002	
Basques	F	17	-.111	-1.04x	-.35	
Basques	F	14	.031	.23x	.08	
Sardinians	M	11	-.281	-1.72x	-.71	
Kourganes, Russia		12	-.481	-1.35x	-.81	
Naqada, R. Orbit	M	82	--	--	-.30	
Naqada, L. Orbit	M	61	--	--	-.29	
Naqada, R. Orbit	F	112	--	--	-.30	
Naqada, L. Orbit	F	108	--	--	-.32	
Egyptians	M	700	--	--	-.44	
Egyptians	F	400	--	--	-.32	
Egyptians, Means of 10 Groups	M		--	--	-.46	
Negroes, Kenya	M	45	--	--	-.22	
Andaman Islanders	M	12	-.211	-1.25x	-.52	
Andaman Islanders	F	12	-.261	-1.51x	-.67	
Batavia, Java	M	15	-.031	-.04x	-.15	
Batavia, Java	M	33	-1.371	-.26x	-.66	

TABLE 23

x, Palate Length
y, Palate Breadth i, $\frac{y}{x}$

SKULLS		r xy	r xy (Yx/Yy)	r xy (Yy/Yx)	
Pecos Indian	M	.43	.44	.42	105
Pecos Indian	F	.46	.40	.29	138
Egyptians	M	700	.18	.17	.18	94
Egyptians	F	400	.16	.15	.16	93
		kx	ki	r xi	
Alsatians	M	13	-.391	-1.91x	-.67	
Egyptians	M	700	--	--	-.64	
Egyptians	F	400	--	--	-.61	
Naqada	M	73	--	--	-.45	
Naqada	F	105	--	--	-.52	
Nylam Chinese	M	39	--	--	-.76	
East Asiatic, 11 Groups	M		--	--	-.67	
Java, 5 Groups	M		--	--	-.62	

TABLE 24
Lag in Egyptian Skulls
(Biometrika, vol. 16, .. 1924)

y	Sex	700 Male - r xy	700 Male - r xy (Yx/Yy)	400 Female - r xy (Yy/Yx)	Ratio of Lags
x, Skull Length					
SKULLS					
Nasal Height	M	.28	.15	.60	30
Nasal Height	F	.27	.14	.62	26
Nasal Breadth	M	.24	.10	.56	18
Nasal Breadth	F	.18	.09	.52	16
Palate Length	M	.34	.16	.74	22
Palate Length	F	.20	.08	.47	17
x, Skull Breadth					
Nasal Height	M	.11	.07	.19	37
Nasal Height	F	.16	.10	.24	40
Nasal Breadth	M	.11	.05	.24	21
Nasal Breadth	F	.07	.03	.15	20
x, Basio-Bregmatic Height					
Auricular Height	M	.73	.75	.70	107
Auricular Height	F	.73	.74	.71	104
Nasal Height	M	.14	.09	.22	41
Nasal Height	F	.14	.09	.23	39
Nasal Breadth	M	.06	.03	.11	27
Nasal Breadth	F	.08	.04	.16	25
x, Auricular Height					
Upper Face Height	M	.12	.08	.21	38
Upper Face Height	F	.13	.07	.22	32
Nasal Height	M	.07	.05	.11	45
Nasal Height	F	.04	.02	.06	33
x, Upper Face Height					
Nasal Breadth	M	.09	.07	.11	64
Nasal Breadth	F	.08	.07	.10	70
x, Horizontal Circumference					
Basio-Bregmatic Height	M	.36	.25	.51	49
Basio-Bregmatic Height	F	.26	.18	.38	47
Auricular Height	M	.47	.34	.65	52
Auricular Height	F	.37	.26	.52	50
x, Sagittal Arc					
Skull Length	M	.74	.81	.68	119
Skull Length	F	.70	.77	.61	126
Skull Breadth	M	.49	.44	.60	73
Skull Breadth	F	.48	.42	.60	70
Basio-Bregmatic Height	M	.47	.42	.56	75
Basio-Bregmatic Height	F	.49	.42	.66	64
Auricular Height	M	.66	.61	.71	86
Auricular Height	F	.63	.56	.72	78
Nasion-Nasion Length	M	.11	.10	.14	71
Nasion-Nasion Length	F	.08	.05	.08	62

LAG IN BODY DIMENSIONS

TABLE 24
(Cont.)

Lag in Egyptian Skulls
(Biometrika, vol. 16, 1924)

y	Sex	700 Males - 400 Females			
		r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
x, Sagittal Arc					
Upper Face Height	M	.16	.09	.27	33
Upper Face Height	F	.13	.07	.25	28
Face Breadth	M	.24	.22	.25	88
Face Breadth	F	.17	.13	.21	62
Arc, Nasion-Bregma	M	.69	.48	1.00	48
Arc, Nasion-Bregma	F	.68	.43	1.06	41
Arc, Bregma-Lambda	M	.60	.35	1.03	34
Arc, Bregma-Lambda	F	.38	.21	.67	31
Arc, Lambda-Opisthion	M	.51	.30	.93	32
Arc, Lambda-Opisthion	F	.49	.24	1.02	24
x, Arc, Nasion-Bregma					
Skull Length	M	.48	.76	.31	245
Skull Length	F	.42	.72	.25	288
Upper Face Height	M	.19	.16	.25	70
Upper Face Height	F	.27	.19	.21	67
Arc, Bregma-Lambda	M	.19	.16	.22	73
Arc, Bregma-Lambda	F	.11	.10	.13	77
Arc, Lambda-Opisthion	M	.16	.13	.19	68
Arc, Lambda-Opisthion	F	.11	.08	.14	57
x, Arc, Bregma-Lambda					
Skull Length	M	.38	.70	.20	350
Skull Length	F	.30	.62	.15	387
Upper Face Height	M	.01	.01	.01	100
Upper Face Height	F	.02	.02	.03	67
Arc, Lambda-Opisthion	M	-.16	-.16	-.16	100
Arc, Lambda-Opisthion	F	-.34	.29	.40	72
x, Arc, Lambda-Opisthion					
Skull Length	M	.51	.97	.27	359
Skull Length	F	.44	1.10	.19	579
Upper Face Height	M	.10	.10	.10	100
Upper Face Height	F	.05	.06	.05	120

TABLE 24A

Lag in Body Dimensions

x, Biacromial Dia./
y, Biacromial Dia./
Height of Trunk

Group	Sex	N	r xy	kx	ki
LIVING					
Ethnic Groups, Means	M	10	.98	4.36	.22
x, Biiliac Dia.					
y, Biiliac Dia./Height of Trunk					
LIVING					
Ethnic Groups, Means	M	10	.92	3.63	.23
x, Bitrochanteric Dia.					
y, Bitrochanteric Dia./Stature					
LIVING					
Ethnic Groups, Means	M	10	.93	.72	1.22
x, Bitrochanteric Dia.					
y, Bitrochanteric Dia./Height of Trunk					
LIVING					
Ethnic Groups, Means	M	10	.84	3.19	.22

TABLE 25

Lag in Body Dimensions

x, Antero-Posterior Dia. of Chest
y, Trans. Dia. of Chest

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
LIVING						
Europeans, Means	M	6	.82	1.04	.64	162
x, Chest Circumference						
y, Leg Length						
LIVING						
Greeks, Means	M	13	.84	.41	1.74	24
Tartars, Means	M	22	.89	.55	1.46	38
x, Chest Circumference						
y, Span						
LIVING						
Gypsies, Balkans, Means	M	6	.99	.75	1.30	58
x, Chest Circumference						
y, Chest Circumference/Stature						
LIVING			r xy	kx	ki	
Bulgarians Means	M	20	-.05	-27.411	-.02x	
Bulgarians Means	M	5	.02	1.473	.00x	
Serbs Means	M	11	-.73	-40.331	-.01x	
Balkans Means	M	10	-.06	-1.401	-.02x	
Solomon Islands	M	20	.96	2.221	.41x	

TABLE 25
(Cont.)

x, Chest Circumference
y, Pelvic Breadth

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
LIVING						
U. S. Soldiers	M	866,485	.31	.18	.52	35
California, 1 Month	M & F	47-59	.70	.89	.76	38
California, 3 Month	M & F		.71	.26	.79	33
California, 6 Month	M & F		.62	.30	.77	39
California, 9 Month	M & F		.71	.36	.75	48
California, 12 Month	M & F		.68	.32	.68	47
California, 15 Month	M & F		.73	.34	.71	48
California, 18 Month	M & F		.82	.35	.86	41
California, 24 Month	M & F		.64	.36	.67	54
California, 36 Month	M & F		.65	.40	.55	73
y, Stem Length						
California, 1 Month	M & F	47-59	.56	.57	.55	104
California, 3 Month	M & F		.53	.78	.52	150
California, 6 Month	M & F		.49	.64	.58	110
California, 9 Month	M & F		.61	.62	.59	105
California, 12 Month	M & F		.58	.64	.53	121
California, 15 Month	M & F		.68	.79	.58	136
California, 18 Month	M & F		.63	.75	.54	139
California, 24 Month	M & F		.59	.68	.51	133
California, 36 Month	M & F		.54	.58	.50	116

TABLE 26

Lag in Unilateral & Bilateral Lengths of Long Bones. Males.
(Whater, Biometrika, 28: 264-285, 1936)

No. = 43 - 152
M = Maximum Length
O = Oblique Length

Group	x	y	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
Anglo-Saxon	Tibia MR	Femur MR	.87	1.04	.72	144
Anglo-Saxon	Tibia MR	Femur ML	.88	.98	.80	123
Anglo-Saxon	Tibia MR	Femur OR	.87	1.00	.75	133
Anglo-Saxon	Tibia MR	Femur OL	.86	.96	.76	126
Anglo-Saxon	Tibia ML	Femur MR	.87	1.14	.66	173
Anglo-Saxon	Tibia ML	Femur ML	.89	1.08	.73	148
Anglo-Saxon	Tibia ML	Femur OR	.86	1.09	.68	159
Anglo-Saxon	Tibia ML	Femur OL	.87	1.09	.70	154
Anglo-Saxon	Tibia MR	Humerus MR	.84	1.14	.62	185
Anglo-Saxon	Tibia ML	Humerus ML	.87	.93	.72	130
Anglo-Saxon	Tibia ML	Humerus OR	.85	.96	.73	132
Anglo-Saxon	Tibia ML	Humerus OL	.81	1.06	.61	174
French	Tibia ML	Humerus MR	.82	.86	.79	109
French	Tibia MR	Humerus ML	.83	.81	.84	96
Egyptian	Tibia ML	Humerus ML	.84	.77	.92	84
French	Tibia MR	Humerus MR	.85	.83	.81	110
French	Tibia MR	Humerus ML	.80	.79	.81	98
Egyptians	Tibia MR	Humerus ML	.89	.82	.97	84
Anglo-Saxon	Tibia MR	Radius MR	.81	.80	.88	98
Anglo-Saxon	Tibia MR	Radius ML	.84	.79	.75	112
French	Tibia MR	Radius ML	.80	.81	.78	104
French	Tibia MR	Radius MR	.84	.80	.87	92
French	Tibia ML	Radius MR	.77	.77	.76	102
French	Tibia ML	Radius ML	.78	.77	.82	90
Anglo-Saxon	Radius MR	Humerus MR	.90	.95	.85	112
Anglo-Saxon	Radius MR	Humerus ML	.89	1.07	.77	146
Anglo-Saxon	Radius MR	Humerus OR	.88	.94	.83	113
Anglo-Saxon	Radius MR	Humerus OL	.87	1.04	.70	155
Anglo-Saxon	Radius ML	Humerus MR	.86	.84	.87	97
Anglo-Saxon	Radius ML	Humerus ML	.83	.93	.73	127
Anglo-Saxon	Radius ML	Humerus OR	.80	.79	.80	99
Anglo-Saxon	Radius ML	Humerus OL	.78	.90	.68	133
Anglo-Saxon	Humerus MR	Femur MR	.88	1.01	.76	132
Anglo-Saxon	Humerus MR	Femur ML	.86	.93	.82	112
Anglo-Saxon	Humerus MR	Femur OR	.88	.97	.72	122
Anglo-Saxon	Humerus MR	Femur OL	.87	.94	.82	116
French	Humerus MR	Femur OR	.83	.71	.96	74
French	Humerus MR	Femur OL	.85	.78	.92	84
French	Humerus ML	Femur MR	.81	.79	.80	99
Egyptians	Humerus ML	Femur OR	.92	.91	.97	94
Egyptians	Humerus ML	Femur OL	.85	.80	.80	100
French	Humerus ML	Femur OL	.85	.84	.86	98
Anglo-Saxon	Humerus ML	Femur MR	.83	.95	.72	132
Anglo-Saxon	Humerus ML	Femur ML	.81	.86	.74	118
Anglo-Saxon	Humerus ML	Femur OR	.82	.93	.72	122
Anglo-Saxon	Humerus ML	Femur OL	.85	.92	.78	118
Anglo-Saxon	Humerus OR	Femur MR	.85	.92	.78	118
Anglo-Saxon	Humerus OR	Femur ML	.85	.85	.84	100
Anglo-Saxon	Humerus OR	Femur OR	.87	.90	.83	109
Anglo-Saxon	Humerus OR	Femur OL	.85	.88	.83	106
Anglo-Saxon	Humerus OL	Femur MR	.79	.77	.80	97
Anglo-Saxon	Humerus OL	Femur ML	.81	.73	.89	82
Anglo-Saxon	Humerus OL	Femur OR	.82	.77	.87	89
Anglo-Saxon	Humerus OL	Femur OL	.85	.79	.91	87

LAG IN BODY DIMENSIONS

TABLE 27

Long Bones

Males 1, $\frac{Y}{X}$
x, Femur Length

y	50 French		46 Chinese		32 Ainu		24 Negada	
	r xy	r xi	r xy	r xi	r xy	r xi	r xy	r xi
Tibia	.81	-.46	.92	-.15	.83	-.21	.92	-.43
Humerus	.86	-.51	.74	-.46	.86	-.30	.86	-.36
Radius	.74	-.50	.67	-.38	.79	-.26	.85	-.42
x, Tibia								
Humerus	.86	-.32	.69	-.51	.74	-.45	.85	-.18
Radius	.78	-.36	.76	-.37	.86	-.28	.85	-.25
x, Femur + Tibia								
Femur	.96	-.19	.98	-.06	.95	-.18	.98	-.43
Humerus + Radius	.91	-.42	.80	-.46	.89	-.39	.90	-.32
x, Humerus								
Radius	.84	-.23	.67	-.31	.78	-.24	.82	-.35
x, Humerus + Radius								
Humerus	.99	-.40	.93	-.06	.95	-.35	.97	-.36

TABLE 28

x, Forearm Length
y, Foot Length

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
English Criminals	M	3000	.80	.76	.84	90
Egyptians, Cairo	M	802	.76	.73	.79	92
y, Finger Length						
English Criminals	M	3000	.85	.78	.92	85
Egyptians, Cairo	M	802	.83	.71	.98	72
x, Foot Length y, Finger Length						
English Criminals	M	3000	.76	.73	.78	94
Egyptians, Cairo	M	802	.76	.68	.86	79

TABLE 28A

x, Length of Hand
y, Length of Leg

LIVING						
Ganda, Central Africa Clans	M	15	.12	.15	.10	150
	F	15	.44	.56	.41	136
	M	15	.60	.50	.41	220
	M	15	-.47	-.41	-.54	76
	F	15	.40	.47	.34	138
	M	15	.49	.41	.58	71
	M	15	.76	1.26	.47	264
	M	27	.47	.44	.49	90
	F	15	.61	.82	.60	102
	F	15	.20	.32	.12	267
	M	15	.35	.32	.39	82
	M	15	.56	.67	.47	142
	M	15	.14	.10	.18	56
	F	15	.58	.64	.52	123
	F	15	.73	.80	.67	119
	F	15	.70	.63	.77	82
	M	15	.33	.31	.35	88
	F	15	.26	.24	.27	89
	F	15	.31	.31	.31	100
	M	15	-.05	-.09	-.02	450
	F	15	.74	1.05	.52	202
	F	15	.68	.79	.58	136
	F	15	.73	1.28	.40	180
	M	15	.58	.75	.46	167
	F	15	.66	.70	.62	113
	M	15	.43	.33	.57	58
	M	15	.68	.89	.53	207
	M	15	.16	.20	.13	154
	F	15	.22	.27	.17	159
	M	15	.42	.46	.38	121
	M	15	.53	.65	.43	151
	F	15	.27	.24	.30	80
	M	18	.37	.44	.32	138
	F	16	.56	.63	.46	140
Means	M	14	.03	.05	.02	250
Means	F	16	.26	.17	.40	42
	M	15	.78	1.10	.55	200
	M	15	.35	.34	.36	94

TABLE 29

Lag in Bones of Hand. German Females. Data of Pfitzner (Lowens and Whiteley, Biometrika, 1)

R, 37-47; R, Right; L, Left; R and L with Subscript Number, as R_2, L_3, indicate Length of Fingers; m, Metacarpal; p, Phalanx, Proximal; m, Middle Phalanx; d, Distal Phalanx; 1, $\frac{Y}{X}$

x	y	r xy	r xi	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
R_2	R_3	.96	.13	.89	1.04	84
	R_4	.95	.16	.85	1.06	82
	R_5	.90	.21	.78	1.12	69
R_3	R_4	.96	-.04	.93	.99	94
	R_5	.92	.13	.80	1.06	75
R_4	R_5	.93	.11	.83	1.04	79
L_2	L_3	.95	-.23	.97	.93	104

TABLE 29
(Cont..)

Lag in Bones of Hand

x	y	r xy	r xi	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
	L_4	.94	.06	.87	1.02	85
	L_5	.90	-.11	.86	.95	91
L_3	L_4	.95	.15	.85	1.05	81
	L_5	.89	-.09	.83	.96	86
L_4	L_5	.89	-.29	.92	.86	107
R_{m_1}	R_{p_1}	.82	-.26	.85	.79	108
	R_{d_1}	.59	-.61	.68	.45	144
R_{p_1}	R_{d_1}	.68	-.57	.67	.51	131
L_{m_1}	L_{p_1}	.82	-.08	.72	.95	76
	L_{d_1}	.67	-.52	.72	.61	108
L_{p_1}	L_{d_1}	.54	-.62	.72	.45	148
R_{m_2}	R_{p_2}	.84	-.26	.82	.85	96
	R_{d_2}	.82	-.04	.82	.82	98
	R_{m_2}	.53	-.49	.54	.53	102
p_2	d_2	.83	-.00	.70	1.00	70
	m_2	.45	-.40	.43	.56	77
d_2	m_2	.58	-.52	.54	.60	108
L_{m_2}	L_{p_2}	.80	-.24	.75	.84	89
	L_{d_2}	.69	-.13	.64	.88	61
	L_{m_2}	.52	-.44	.48	.55	87
p_2	d_2	.86	-.05	.78	1.05	70
	m_2	.50	-.45	.50	.51	98
d_2	m_2	.48	-.53	.57	.40	143
R_{m_3}	R_{p_3}	.81	-.33	.88	.80	103
	R_{d_3}	.74	-.11	.81	.91	87
p_3	d_3	.70	-.02	.50	.97	52
	m_3	.90	.22	.72	1.12	65
d_3	m_3	.69	-.21	.98	.50	50
L_{m_3}	L_{p_3}	.68	-.26	.60	.77	78
	L_{d_3}	.80	-.29	.78	.82	95
	L_{m_3}	.68	-.09	.51	.91	56
p_3	d_3	.69	-.09	.51	.92	55
	m_3	.84	.13	.64	1.09	57
d_3	m_3	.57	-.23	.44	.76	59
R_{m_4}	R_{p_4}	.80	-.05	.60	1.00	60
	R_{d_4}	.81	-.17	.73	.89	82
p_4	d_4	.50	.05	.62	1.04	60
	m_4	.70	-.12	.56	.89	62
d_4	m_4	.90	.12	.72	1.06	72
L_{m_4}	L_{p_4}	.63	-.29	.84	.72	75
	L_{d_4}	.67	-.45	.68	.65	105
	L_{m_4}	.79	-.15	.78	.81	96
p_4	d_4	.73	-.04	.66	.96	68
	m_4	.58	-.24	.46	.74	62
d_4	m_4	.84	.12	.66	1.29	51
R_{m_5}	R_{p_5}	.62	-.43	.50	.78	64
	R_{d_5}	.60	-.47	.61	.58	105
	R_{m_5}	.81	-.17	.74	.89	83
p_5	d_5	.63	.01	.61	.99	61
	m_5	.51	-.32	.41	.64	64
d_5	m_5	.81	.18	.57	1.16	49
L_{m_5}	L_{p_5}	.84	.30	.58	.73	77
	L_{d_5}	.43	-.67	.64	.35	184
	L_{m_5}	.80	-.20	.74	.87	85
p_5	d_5	.57	-.16	.41	.81	51
	m_5	.46	-.38	.37	.55	67
d_5	m_5	.68	-.10	.52	.90	58
R_{m_1}	R_{p_1}	.46	-.43	.41	.52	79
	R_{d_1}	.36	-.66	.42	.31	136
	R_{m_1}	.81	-.54	.90	.68	141
R_{m_2}	R_{p_2}	.82	-.58	1.01	.66	153
	R_{d_2}	.73	-.69	.90	.53	153
	R_{m_2}	.66	-.57	.78	.56	139
R_{m_3}	R_{p_3}	.94	-.28	.98	.91	108
	R_{d_3}	.91	-.30	.96	.88	108
	R_{m_3}	.86	-.26	.86	.86	100
R_{m_4}	R_{p_4}	.95	-.17	.95	.94	101
	R_{d_4}	.89	-.16	.86	.92	92
R_{m_5}	R_{p_5}	.93	-.07	.89	.97	92
	R_{d_5}	.78	-.48	.70	.86	81
L_{m_1}	L_{p_1}	.79	-.56	.95	.66	144
	L_{d_1}	.70	-.50	.79	.63	125
	L_{m_1}	.66	-.49	.72	.61	118
L_{m_2}	L_{p_2}	.94	-.37	1.01	.87	116
	L_{d_2}	.91	-.20	.90	.91	99
	L_{m_2}	.89	-.17	.86	.92	93
L_{m_3}	L_{p_3}	.93	.13	.86	1.00	86
	L_{d_3}	.88	-.04	.79	.98	81
L_{m_4}	L_{p_4}	.95	-.08	.92	.97	95
R_{p_1}	R_{d_1}	.84	-.46	.94	.73	128
	R_{m_1}	.82	-.55	.98	.68	144
	R_{d_2}	.80	-.42	.87	.74	118
R_{p_2}	R_{m_2}	.85	-.33	.89	.82	109
	R_{d_3}	.94	-.36	1.00	.87	126
	R_{m_3}	.89	-.15	.85	.93	91
R_{p_3}	R_{d_3}	.89	-.07	.83	.96	86
	R_{m_3}	.95	.16	.85	1.06	82
R_{p_4}	R_{d_4}	.92	.13	.79	1.06	75
	R_{m_4}	.92	-.11	.88	.95	93
L_{p_1}	L_{d_1}	.87	-.57	1.06	.72	147
	L_{m_1}	.87	-.70	1.17	.64	182
	L_{m_2}	.82	-.60	1.03	.64	161
L_{p_2}	L_{d_2}	.78	-.51	.90	.67	134
	L_{m_2}	.91	-.44	1.02	.82	124
L_{p_3}	L_{d_3}	.88	-.31	.91	.85	107
	L_{m_3}	.86	-.18	.82	.90	91
L_{p_4}	L_{d_4}	.93	.00	.86	1.00	86
	L_{m_4}	.88	-.01	.73	1.01	72
R_{m_2}	R_{p_2}	.91	-.03	.83	.99	84
	R_{d_2}	.90	-.29	.93	.87	107
	R_{m_2}	.91	-.16	.89	.93	96
R_{m_3}	R_{p_3}	.93	-.03	.89	.98	90
	R_{d_3}	.94	-.08	.89	.99	90
	R_{m_3}	.75	-.00	.57	1.00	57
R_{m_4}	R_{p_4}	.94	-.08	.87	1.08	80
	R_{d_4}	.92	-.25	.95	.90	106
	R_{m_4}	.93	-.09	.90	.96	94
R_{m_5}	R_{p_5}	.89	-.08	.71	.92	77
	R_{d_5}	.96	-.09	.91	1.08	89
	R_{m_5}	.76	-.13	.65	.90	72
L_{m_1}	L_{p_1}	.86	-.08	.77	.95	81
	L_{d_1}	.60	-.29	.61	.71	72
	L_{m_1}	.63	-.14	.67	.85	79
	L_{d_2}	.73	-.12	.60	.90	67
	L_{d_5}	.68	-.16	.54	.85	64

LAG IN BODY DIMENSIONS

TABLE 29
(Cont.)

Lag in Bones of Hand

x	y	r xy	r x1	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
d_2	d_3	.80	-.12	.70	.91	77
	d_4	.79	-.26	.75	.82	91
	d_5	.80	-.22	.75	.85	88
d_3	d_4	.86	-.42	.96	.79	119
	d_5	.77	-.43	.82	.72	114
d_4	d_5	.83	-.26	.81	.85	95
La_1	d_2	.70	-.39	.70	.70	100
	d_3	.74	-.19	.84	.65	129
	d_4	.75	-.13	.83	.69	121
	d_5	.59	-.31	.59	.69	72
d_2	d_3	.86	-.01	.74	.99	75
	d_4	.82	-.03	.88	.98	89
	d_5	.80	-.08	.68	.94	72
d_3	d_4	.92	-.12	.88	.96	93
	d_5	.75	-.33	.74	.76	97
d_4	d_5	.80	-.34	.82	.78	105

TABLE 30

Correlations and Lags in Weights of 48-49 Left Hand Bones
(Pyle, SH. 7:109-113, 1935)

x	y	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
Greater Multangular	Lesser Multangular	.88	.85	.91	93
Greater Multangular	Capitate	.87	.89	.85	105
Greater Multangular	Hamate	.79	.88	.71	124
Greater Multangular	Navicular	.76	.77	.75	103
Greater Multangular	Lunate	.76	.79	.73	108
Greater Multangular	Triquetral	.74	.73	.75	97
Lesser Multangular	Capitate	.89	.93	.85	109
Lesser Multangular	Hamate	.85	.97	.75	129
Lesser Multangular	Navicular	.84	.87	.81	107
Lesser Multangular	Lunate	.77	.83	.71	117
Lesser Multangular	Triquetral	.76	.78	.74	105
Hamate	Capitate	.89	.82	.97	84
Hamate	Navicular	.83	.76	.90	84
Navicular	Capitate	.85	.85	.85	100
Lunate	Capitate	.82	.80	.84	95
Lunate	Hamate	.82	.87	.77	113
Lunate	Navicular	.79	.77	.81	95
Lunate	Triquetral	.77	.73	.81	90
Triquetral	Capitate	.77	.78	.75	104
Triquetral	Hamate	.80	.89	.72	124
Triquetral	Navicular	.70	.71	.69	103
Pisiform	Greater Multangular	.50	.57	.44	130
Pisiform	Lesser Multangular	.43	.47	.39	120
Pisiform	Capitate	.52	.61	.46	133
Pisiform	Hamate	.61	.71	.44	161
Pisiform	Navicular	.47	.44	.41	112
Pisiform	Lunate	.48	.47	.40	142
Pisiform	Triquetral	.41	.49	.34	126
1st Metacarpal	2nd Metacarpal	.86	.86	.86	100
1st Metacarpal	3rd Metacarpal	.81	.80	.82	98
1st Metacarpal	4th Metacarpal	.80	.77	.83	93
1st Metacarpal	5th Metacarpal	.81	.78	.84	93
2nd Metacarpal	3rd Metacarpal	.90	.88	.92	96
2nd Metacarpal	4th Metacarpal	.89	.85	.93	91
2nd Metacarpal	5th Metacarpal	.90	.86	.96	91
3rd Metacarpal	4th Metacarpal	.92	.89	.96	94
3rd Metacarpal	5th Metacarpal	.93	.90	.96	94
4th Metacarpal	5th Metacarpal	.90	.90	.90	100
1st Proximal Phalanx	2nd Proximal Phalanx	.93	.92	.94	98
1st Proximal Phalanx	3rd Proximal Phalanx	.88	.84	.93	90
1st Proximal Phalanx	4th Proximal Phalanx	.84	.82	.86	95
1st Proximal Phalanx	5th Proximal Phalanx	.89	.86	.92	93
2nd Proximal Phalanx	3rd Proximal Phalanx	.93	.89	.97	92
2nd Proximal Phalanx	4th Proximal Phalanx	.95	.94	.96	98
2nd Proximal Phalanx	5th Proximal Phalanx	.90	.88	.92	96
3rd Proximal Phalanx	4th Proximal Phalanx	.95	.98	.92	106
3rd Proximal Phalanx	5th Proximal Phalanx	.93	.95	.91	104
4th Proximal Phalanx	5th Proximal Phalanx	.90	.89	.91	98
2nd Middle Phalanx	3rd Middle Phalanx	.92	.92	.92	100
2nd Middle Phalanx	4th Middle Phalanx	.86	.89	.83	107
2nd Middle Phalanx	5th Middle Phalanx	.89	.88	.90	98
3rd Middle Phalanx	4th Middle Phalanx	.91	.94	.88	107
3rd Middle Phalanx	5th Middle Phalanx	.90	.89	.91	98
4th Middle Phalanx	5th Middle Phalanx	.94	.90	.98	92
1st Distal Phalanx	2nd Distal Phalanx	.81	.72	.91	79
1st Distal Phalanx	3rd Distal Phalanx	.88	.77	1.00	77
1st Distal Phalanx	4th Distal Phalanx	.86	.83	.89	93

TABLE 30
(Cont.)

x	y	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
1st Distal Phalanx	5th Distal Phalanx	.88	1.83	.42	436
2nd Distal Phalanx	3rd Distal Phalanx	.86	.85	.87	98
2nd Distal Phalanx	4th Distal Phalanx	.70	.77	.64	120
2nd Distal Phalanx	5th Distal Phalanx	.81	1.90	.34	560
3rd Distal Phalanx	4th Distal Phalanx	.80	.88	.73	120
3rd Distal Phalanx	5th Distal Phalanx	.83	1.97	.35	563
4th Distal Phalanx	5th Distal Phalanx	.84	1.80	.39	460

TABLE 31

x, Head Circumference

y	Germans 1300 Male r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags	Germans 1000 Female r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
Head Height	.18	.52	30	.19	.59	32
Stem Length	.17	.42	39	.17	.42	40
Arm Length	.11	.30	37	.14	.40	35
Leg Length	.06	.17	35	.08	.12	33
Stature, Means of 32 Groups of French Soldiers	.24	.12	21 (r xy = .52)			

TABLE 32

x, Trunk Length
y, Leg Length

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
North Sweden	M	4795	.18	.17	.19	92
West Sweden	M	13222	.17	.17	.17	97
East Sweden	M	15497	.18	.18	.18	100
South Sweden	M	8714	.18	.18	.18	102
Cities of Sweden	M	4795	.20	.19	.21	88
Total Sweden	M	47387	.18	.18	.18	96
x, Arm Length y, Trunk Length						
North Sweden	M	4795	.33	.35	.31	115
West Sweden	M	13222	.51	.56	.29	117
East Sweden	M	15497	.51	.54	.28	115
South Sweden	M	8714	.50	.53	.27	123
Cities of Sweden	M	4795	.51	.55	.30	110
Total Sweden	M	47387	.51	.54	.29	117
Germans	M	249	--	.43	.32	134
Germans	F	842	--	.36	.28	129
x, Arm Length y, Leg Length						
North Sweden	M	4795	.80	.71	.90	79
West Sweden	M	13222	.79	.72	.85	85
East Sweden	M	15497	.79	.73	.86	85
South Sweden	M	8714	.78	.71	.86	83
Cities of Sweden	M	4795	.80	.72	.89	81
Total Sweden	M	47387	.80	.73	.88	83
Germans	M	1285	--	.60	.79	76
Germans	F	1017	--	.50	.67	75

TABLE 33

x, Shoulder Breadth
y, Pelvic Breadth

North Sweden	M	4795	.40	.33	.48	69
West Sweden	M	13222	.39	.31	.49	64
East Sweden	M	15497	.37	.29	.47	62
South Sweden	M	8714	.40	.32	.49	66
Cities of Sweden	M	4795	.37	.31	.44	71
Total	M	47387	.38	.30	.48	64
New York Children						
Age 3 Years	M	18	.39	.37	.41	90
Age 6 Years	M	20	.75	1.16	.49	240
Age 5 Years	M	18	.74	.97	.56	173
Age 6 Years	M	19	.69	1.00	.48	208
Age 7 Years	M	22	.64	.80	.51	156
Age 8 Years	M	14	.70	.71	.69	102
Age 3 Years	F	21	.61	.63	.59	105
Age 4 Years	F	22	.68	.61	.55	110
Age 5 Years	F	20	.66	.44	.68	93
Age 6 Years	F	25	.80	.89	.72	125
Age 7 Years	F	22	.64	.58	.66	93
Age 8 Years	F	13	.68	.48	.55	76
California Children						
Age 1 Month	M & F	47-59	.62	.40	.98	41
Age 3 Months	M & F	47-59	.69	.36	1.01	34
Age 6 Months	M & F	47-59	.47	.34	.65	52
Age 9 Months	M & F	47-59	.61	.49	.77	64
Age 12 Months	M & F	47-59	.47	.34	.60	60
Age 15 Months	M & F	47-59	.64	.51	.79	64
Age 18 Months	M & F	47-59	.70	.51	.95	54
Age 24 Months	M & F	47-59	.61	.54	.69	78
Age 36 Months	M & F	47-59	.65	.46	.90	51

LAG IN BODY DIMENSIONS

TABLE 34

x, Trunk Length
y, Pelvic Breadth

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
North Sweden	M	4795	.32	.29	.35	83
West Sweden	M	13222	.31	.27	.36	74
East Sweden	M	15907	.29	.26	.33	77
South Sweden	M	8714	.32	.29	.36	79
Cities of Sweden	M	4795	.31	.27	.36	76
Total Sweden	M	47387	.30	.26	.34	76
California Children						
Age, 1 Months	M & F	47-59	.64	.39	1.06	37
Age, 3 Months	M & F	47-59	.58	.27	1.23	22
Age, 6 Months	M & F	47-59	.59	.19	.81	23
Age, 9 Months	M & F	47-59	.40	.22	.73	30
Age, 12 Months	M & F	47-59	.64	.39	1.04	37
Age, 15 Months	M & F	47-59	.72	.42	1.21	35
Age, 18 Months	M & F	47-59	.67	.41	1.09	38
Age, 24 Months	M & F	47-59	.58	.37	.91	41
Age, 36 Months	M & F	47-59	.60	.48	.76	63

TABLE 35

x, Trunk Length
y, Shoulder Breadth

North Sweden	M	4795	.26	.29	.24	121
West Sweden	M	13222	.28	.30	.26	117
East Sweden	M	15907	.28	.31	.26	123
South Sweden	M	8714	.28	.31	.26	121
Cities of Sweden	M	4795	.23	.24	.22	106
Total Sweden	M	47387	.27	.29	.25	117
California Children						
Age, 1 Months	M&F	47-59	.45	.43	.48	90
Age, 3 Months	M&F	47-59	.69	.47	.77	61
Age, 6 Months	M&F	47-59	.50	.33	.74	44
Age, 9 Months	M&F	47-59	.60	.56	.71	78
Age, 12 Months	M&F	47-59	.54	.43	.69	62
Age, 15 Months	M&F	47-59	.63	.46	.85	54
Age, 18 Months	M&F	47-59	.49	.42	.58	72
Age, 24 Months	M&F	47-59	.61	.37	.70	53
Age, 36 Months	M&F	47-59	.53	.59	.48	123

TABLE 36

x, Stature
y, Arm Length

English Criminals	M	3000	.80	.71	.90	79
Egyptian (Cairo)	M	802	.80	.63	1.03	61
English (Fathers)	M	1079	.64	.49	.84	58
English (Sons)	M	1401	.69	.51	.92	55
English (Mothers)	F	1079	.60	.44	.81	54
English (Daughters)	F	1401	.72	.54	.95	57
French Cadavers	M	44	.84	.78	.90	87
French Cadavers Humerus	M	44	.77	.72	.83	87
French Cadavers Ulna	M	44	.84	.79	.89	89
French Cadavers Radius	M	44	.80	.64	1.00	64
Germans	M	1273	---	.63	---	---
Germans	F	1004	---	.45	---	---
New York Children						
Age, 2 Years	M	19	.96	.58	1.60	36
Age, 3 Years	M	29	.74	.61	.89	69
Age, 4 Years	M	33	.86	.52	1.45	36
Age, 5 Years	M	38	.80	.51	1.26	41
Age, 6 Years	M	24	.81	.62	1.06	59
Age, 7 Years	M	21	.86	.52	1.45	36
Age, 8 Years	M	16	.91	.58	1.42	41
Age, 2 Years	F	21	.72	.36	1.44	25
Age, 3 Years	F	30	.87	.46	1.64	28
Age, 4 Years	F	34	.88	.51	1.52	33
Age, 5 Years	F	34	.72	.53	.99	54
Age, 6 Years	F	28	.83	.41	1.69	24
Age, 7 Years	F	22	.86	.60	1.23	49
Age, 8 Years	F	15	.87	.54	1.40	39

TABLE 37

x, Stature
y, Arm Length 1, $\frac{Y}{x}$

Group	Sex	N	r x1	Group	Sex	N	r x1
East Holstein	M	260	-.03	French (Total)	M	50	.09
East Holstein	F	310	-.02	French (Humerus)		50	.17
English				French (Radius)		50	.01
Criminals	M	3000	-.15	French Cadavers			
Ramas Indians	M	25	.21	(Total)		44	-.16
Chinese				French Cadavers			
(Total Arm)	M	48	-.25	(Humerus)		44	-.25
Chinese				French Cadavers			
(Humerus)	M	48	-.26	(Ulna)		44	-.19
Chinese (Radius)	M	48	-.13	French Cadavers			
				(Radius		44	.001

x, Stature y, Leg Length 1, $\frac{Y}{x}$							
French	M	50	.29	Chinese	M	48	.10
French (Tibia)	M	50	.16	Chinese (Tibia)		48	.19
French (Femur)	M	50	.32	Chinese (Femur)		48	.02
French Cadavers	M	44	-.25	French Cadavers			
French Cadavers				(Tibia)			-.18
(Femur)	M	44	-.10	French Cadavers			
				(Fibula)			-.11
Oxford, 18 Yrs.	M	129	.42	Oxford, 21 Yrs.	M	137	.48
Oxford, 19 Yrs.	M	330	.35	Oxford, 22 Yrs.		95	.40
Oxford, 20 Yrs.	M	209	.39				

TABLE 38

x, Stature
y, Chest Circumference 1, $\frac{Y}{x}$

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
London Police	M	100	.04	.02	.07	29
Westminster School, 12-16 Years	M	279	.78	.60	1.02	59
London School, 5-13 Years	M	215	.89	1.14	.69	160
Manchester School, 11 Years	M	29	.22	.17	.28	61
Manchester School, 12 Years	M	112	.65	.63	.68	93
Manchester School, 13 Years	M	173	.67	.60	.74	81
Manchester School, 14 Years	M	255	.65	.55	.76	72
Manchester School, 15 Years	M	263	.69	.52	.91	57
Manchester School, 16 Years	M	173	.65	.50	.85	59
Manchester School, 17 Years	M	80	.51	.33	.79	42
Manchester School, 18 Years	M	25	.37	.32	.43	74
Manchester School, 11-18 Years	M	1110	.84	.69	1.03	67
California						
1, Month	M&F	47-59	.50	.43	.57	75
3, Months	M&F	47-59	.55	.44	.67	66
6, Months	M&F	47-59	.56	.41	.71	58
9, Months	M&F	47-59	.65	.58	.73	79
12, Months	M&F	47-59	.60	.48	.75	64
15, Months	M&F	47-59	.63	.51	.78	65
18, Months	M&F	47-59	.53	.44	.63	70
24, Months	M&F	47-59	.69	.52	.87	60
36, Months	M&F	47-59	.55	.50	.60	83
U. S. Soldiers	M	868,845	.25	.15	.35	43
English Air Force Candidates	M	1238	.34	$\frac{r\ xy}{r^2}$ = .32		
English Air Force Candidates	M	950	.34	-.33		
London Police	M	100	.04	-.88		

TABLE 39

x, Stature
y, Foot Length

English Criminals	M	3000	.74	.68	.87	71
Egyptians, Cairo	M	802	.72	.54	.95	57
y, Finger Length						
English Criminals	M	3000	.66	.54	.81	67
Egyptians, Cairo	M	802	.66	.44	.99	44
Germans (Ray III)	M&F	249	---	.65	.84	77
y, Foot Length			kx	x1	r x1	
Ramas Indians	M	25	33.621	.002x	.08	
English Criminals	M	3000	---	---	-.16	
y, Foot Breadth						
Ramas Indians	M	25	-4.161	-.004x	-.13	
y, Hand Length						
Ramas Indians	M	25	41.431	.001x	.24	

TABLE 40

x, Stature
y, Head Breadth

Children, Age 6-17 Yrs						
Worcester, 6 Years	M	105	.20	.30	.13	231
7 Years	M	142	.27	.35	.20	175
8 Years	M	126	.19	.25	.15	167
9 Years	M	167	.23	.30	.17	176
10 Years	M	157	.31	.43	.22	195
11 Years	M	151	.29	.38	.22	173
12 Years	M	177	.24	.28	.21	133
13 Years	M	148	.28	.45	.18	250
14 Years	M	154	.11	.18	.06	300
15 Years	M	152	.33	.55	.20	275
16 Years	M	96	.17	.21	.14	150
17 Years	M	49	.25	.25	.25	100
6 Years	F	84	.34	.56	.21	267
7 Years	F	101	.17	.28	.10	280
8 Years	F	105	.12	.19	.08	238
9 Years	F	118	.17	.21	.14	150
10 Years	F	160	.18	.28	.12	233
11 Years	F	152	.12	.20	.07	286
12 Years	F	165	.44	.67	.29	231
13 Years	F	142	.24	.32	.18	178
14 Years	F	115	.42	.53	.33	161
15 Years	F	109	.09	.10	.08	125
16 Years	F	91	.15	.17	.13	131
17 Years	F	69	.06	.07	.05	140
ADULTS						
Aberdeen, Normal	M	787	.22	.24	.19	129
Aberdeen, Insane	M	297	.26	.34	.19	179
Banff, Normal	M	105	.16	.16	.16	99
Banff, Insane	M	84	.12	.15	.10	156
Scottish Soldiers	M	2687	.19	.20	.18	110
Scottish, Insane	M	4381	.20	.24	.17	147
83 Ethnic Groups	M&F		-.04	-.03	-.06	50
English Criminals	M	3000	.18	.21	.16	131
Oxford Students, 18 Years	M	129	.05	.05	.05	100
Oxford Students, 19 Years	M	330	.17	.19	.17	112
Oxford Students, 20 Years	M	209	.19	.21	.17	124

LAG IN BODY DIMENSIONS

TABLE 40
(Cont.)

x, Stature
y, Head Breadth

Group	Sex	N	r xy	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Lags
ADULTS						
Oxford Students, 21 Years	M	137	.10	.13	.08	162
Oxford Students, 22 Years	M	95	.17	.18	.16	112
Cambridge Students	M	1000	.15	.17	.14	121

TABLE 41

x, Stature
y, Head Height

Aberdeen, Normal	M	787	.25	.21	.29	72
Aberdeen, Insane	M	297	.17	.19	.15	125
Banff, Normal	M	105	.08	.07	.09	72
Banff, Insane	M	84	.21	.20	.22	93
Scottish Soldiers	M	2687	.26	.23	.29	78
Scottish, Insane	M	4361	.23	.25	.22	112
Oxford Students, 18 Years	M	189	.09	.07	.12	58
Oxford Students, 19 Years	M	330	.28	.23	.33	70
Oxford Students, 20 Years	M	209	.31	.27	.35	77
Oxford Students, 21 Years	M	137	.32	.33	.31	106
Oxford Students, 22 Years	M	95	.42	.36	.49	73
53 Ethnic Groups			.10	.04	.24	167

TABLE 42

x, Stature
y, Head Length $1, \frac{Y}{X}$

83 Ethnic Groups	MAF		.10	.13	.07	186
Aberdeen, Normal	M	787	.34	.41	.28	150
Aberdeen, Insane	M	297	.31	.42	.23	179
Banff, Normal	M	105	.31	.32	.31	106
Scottish Soldiers	M	2687	.27	.29	.24	121
Scottish, Insane	M	4361	.33	.42	.26	166
English Criminals	M	3000	.34	.42	.28	150
North Sweden, 21 Yrs.	M	4795	.25	.28	.23	121
West Sweden, 21 Yrs.	M	13222	.24	.26	.22	114
East Sweden, 21 Yrs.	M	15497	.25	.27	.24	113
South Sweden, 21 Yrs.	M	8714	.27	.30	.25	119
Cities Sweden, 21 Yrs.	M	4795	.28	.31	.26	120
Total Sweden. 21 Yrs.	M	47387	.25	.27	.23	116
OXFORD STUDENTS						
18 Years	M	189	.22	.23	.21	110
19 Years	M	330	.31	.36	.27	133
20 Years	M	209	.35	.39	.31	126
21 Years	M	137	.36	.41	.30	141
22 Years	M	95	.33	.39	.28	139
Cambridge Students	M	1000	.28	.33	.24	138
			xx	xy	r xi	
Swedish, 25 Groups	M		-.277	-.20x	-.50	
OXFORD STUDENTS						
18 Years	M	189	--	--	-.64	
19 Years	M	330	--	--	-.66	
20 Years	M	209	--	--	-.65	
21 Years	M	137	--	--	-.67	
22 Years	M	95	--	--	-.68	
Cambridge Students	M	1000	--	--	-.68	
English Criminals	M	3000	--	--	-.69	
WORCESTER						
6 Years	M	103	.30	.43	.21	205
7 Years	M	148	.36	.45	.30	145
8 Years	M	120	.44	.61	.32	191
9 Years	M	167	.41	.52	.33	154
10 Years	M	161	.41	.46	.21	219
11 Years	M	191	.38	.53	.29	183
12 Years	M	177	.36	.45	.27	181
13 Years	M	168	.32	.48	.21	229
14 Years	M	154	.39	.62	.25	248
15 Years	M	152	.42	.66	.27	244
16 Years	M	96	.31	.36	.26	138
17 Years	M	49	.19	.20	.18	111
6 Years	F	84	.21	.33	.13	254
7 Years	F	101	.37	.51	.27	189
8 Years	F	105	.38	.45	.25	196
9 Years	F	118	.38	.45	.32	141
10 Years	F	160	.36	.45	.24	221
11 Years	F	152	.37	.69	.20	385
12 Years	F	165	.38	.65	.23	274
13 Years	F	142	.40	.49	.33	148
14 Years	F	115	.37	.49	.28	175
15 Years	F	109	.14	.17	.12	142
16 Years	F	91	.27	.33	.22	150
17 Years	F	69	.32	.55	.29	191

TABLE 43

x, Stature
y, Various Head Measurements

Y. Face Breadth						
English Criminals	M	3000	.34	.36	.33	109
58 Ethnic Groups	MAF		-.17	-.09	-.32	28
Y. Face Length						
43 Russian Groups	MAF		-.06	-.04	-.10	50
Y. Head Height						
Germans	M	1685	--	--	.27	--
Germans	F	1359	--	--	.13	--

TABLE 43
(Cont.)

x, Stature
y, Various Head Measurements

Group	Sex	N	r xy	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Lags
Y. Head Circumference						
Germans	M	1679	--	.34	.21	162
Germans	F	1364	--	.30	.15	200
Germans	M	1682	--	--	.21	--
Germans	F	1358	--	--	.14	--
Germans 20-40 Years	M	414	--	--	.19	--
Germans 20-40 Years	F	346	--	--	.12	--
Germans 20-40 Years	M	1679	--	--	.04	--
Germans	F	1364	--	--	.01	--
Y. Cranial Capacity						
Norwegians, 18 Groups	MAF		.30	.21	.42	50
Scandinavians, 10 Groups	MAF		.56	.29	1.11	26

TABLE 44

x, Stature
y, Leg Length (Tibiale to Heel)

NEW YORK CHILDREN						
3 Years	M	14	.68	.79	.98	81
4 Years	M	16	.85	.71	1.02	69
5 Years	M	26	.91	.63	1.32	47
6 Years	M	18	.92	.72	1.14	63
7 Years	M	22	.76	.66	.89	73
8 Years	M	14	.91	.77	1.07	71
3 Years	F	11	.86	.83	.90	92
4 Years	F	21	.82	.68	1.08	67
5 Years	F	20	.79	.70	.89	79
6 Years	F	23	.68	.58	.89	65
7 Years	F	22	.81	.69	.96	72
8 Years	F	12	.75	.68	.83	82

TABLE 45

x, Stature
y, Leg Length

North Sweden, 21 Yrs.	M	4795	.88	.64	1.21	53
West Sweden, 21 Yrs.	M	13222	.88	.65	1.20	54
East Sweden, 21 Yrs.	M	15497	.87	.64	1.18	54
South Sweden, 21 Yrs.	M	8714	.87	.64	1.17	55
Cities Sweden 21 Yrs.	M	4795	.86	.63	1.17	54
Total Sweden, 21 Yrs.	M	47387	.87	.64	1.18	55
New Guinea	M	38	.92	.65	1.32	49
French Cadavers	M	44	.88	.88	.88	100
French Cadavers, Femur	M	44	.85	.76	.94	81
Tibia	M	44	.89	.86	.92	93
Fibula	M	44	.88	.82	.95	86
OXFORD STUDENTS						
18 Years	M	189	.87	.56	1.36	41
19 Years	M	330	.86	.58	1.28	45
20 Years	M	209	.86	.62	1.28	48
21 Years	M	137	.91	.68	1.33	47
22 Years	M	95	.91	.66	1.85	53
18 Years, Thigh	M	189	.80	.39	1.65	24
19 Years, Thigh	M	330	.74	.41	1.32	31
20 Years, Thigh	M	209	.82	.49	1.37	36
21 Years, Thigh	M	137	.82	.50	1.34	37
22 Years, Thigh	M	95	.83	.52	1.32	39

TABLE 46

x, Stature
y, Pelvic Breadth

North Sweden	M	4795	.51	.35	.76	48
West Sweden	M	13222	.52	.34	.80	42
East Sweden	M	15497	.52	.34	.81	42
South Sweden	M	8714	.52	.34	.80	43
Cities, Sweden	M	4795	.53	.36	.79	46
Total, Sweden	M	47387	.52	.34	.79	43
NEW YORK CHILDREN						
3 Years	M	19	.55	.56	.94	103
4 Years	M	21	.76	.70	.83	84
5 Years	M	24	.66	.61	.72	85
6 Years	M	18	.77	.66	.89	125
7 Years	M	22	.74	.61	.89	69
8 Years	M	14	.84	.73	.97	75
3 Years	F	20	.46	.44	.48	92
4 Years	F	22	.64	.49	.83	59
5 Years	F	20	.55	.49	.62	79
6 Years	F	24	.67	.40	1.12	36
7 Years	F	23	.69	.58	.82	71
8 Years	F	13	.70	.52	.93	55
CALIFORNIA CHILDREN						
1 Months	MAF	47-59	.60	.32	1.11	29
3 Months	MAF	47-59	.49	.23	1.04	22
6 Months	MAF	47-59	.34	.16	.70	22
9 Months	MAF	47-59	.49	.24	.98	24
12 Months	MAF	47-59	.65	.36	1.18	30
15 Months	MAF	47-59	.66	.37	1.17	32
18 Months	MAF	47-59	.64	.39	1.04	37
24 Months	MAF	47-59	.67	.40	1.11	36
36 Months	MAF	47-59	.73	.57	.94	61

LAG IN BODY DIMENSIONS

TABLE 47

x, Stature
y, Shoulder Breadth

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
North Swedes	M	4795	.46	.38	.55	69
West Swedes	M	13222	.47	.38	.58	65
East Swedes	M	15497	.48	.39	.59	67
South Swedes	M	8714	.46	.37	.57	65
Cities of Swedes	M	4795	.46	.37	.57	65
Total of Swedes	M	47387	.47	.38	.58	66
NEW YORK CHILDREN						
4 Years	M	21	.71	.76	.66	115
4 Years	M	21	.86	.52	1.43	37
5 Years	M	21	.90	.63	1.29	48
6 Years	M	19	.93	.72	1.21	59
7 Years	M	22	.87	.58	1.30	45
8 Years	M	14	.79	.67	.93	72
3 Years	F	21	.53	.49	.58	84
4 Years	F	20	.81	.45	.84	54
5 Years	F	19	.51	.47	.55	85
6 Years	F	25	.66	.36	1.20	30
7 Years	F	22	.74	.64	.89	72
8 Years	F	13	.56	.48	.66	73
CALIFORNIA CHILDREN						
1 Months	MAF	47-59	.59	.49	.70	70
3 Months	MAF	47-59	.67	.54	.84	64
6 Months	MAF	47-59	.64	.62	.97	63
9 Months	MAF	47-59	.66	.35	.89	39
12 Months	MAF	47-59	.54	.38	.76	50
15 Months	MAF	47-59	.57	.40	.81	49
18 Months	MAF	47-59	.57	.48	.68	70
24 Months	MAF	47-59	.66	.45	.95	47
36 Months	MAF	47-59	.50	.54	.46	117

TABLE 48

x, Stature
y, Stem Length, i, $\frac{y}{x}$

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
U. S. Soldiers	M	868445	.66	.66	.66	100
North Swedes	M	4795	.57	.43	.75	57
West Swedes	M	13222	.58	.43	.77	56
East Swedes	M	15497	.59	.44	.80	54
South Swedes	M	8714	.57	.43	.80	54
Cities of Sweden	M	4795	.47	.37	.60	61
Total Swedes	M	47387	.50	.38	.67	56
French Cadavers	M	44	.95	.86	1.06	81
London Police	M	100	.61	.52	.72	72
Amsterdam Students	M	116	.73	.48	1.11	43
Germans	F	1036	--	.50	--	--
Germans	M	1325	--	.60	--	--

			r_{xi}	r_{xi}	r_{xi}
U. S. Soldiers, W.	M	96239	-52.451	-.02x	-.97
U. S. Soldiers, N.	M	6433	-51.441	-.01x	-.97
Nebraska Students	F	1500	- 9.401	-.10x	-.97
English Air Force Candidates	M	1238	---	---	-.46
English Air Forces Candidates	M	950	---	---	-.46
Holstein	M	260	---	---	-.21
Holstein	F	310	---	---	-.27
Russians, 43 Groups Means	MAF		- .061	-.04x	-.24
London Police	M	100	---	---	-.58
Negroes, U. S.	M	20	- 3.061	-.08x	-.51
Hanas Indians	M	25	- 8.171	-.005x	-.20
Winnipeg Indians	M	29	---	-.05x	---
Little Grand Rapids Indians	M	41	---	-.06x	---
Berens River Indians	M	43	---	-.12x	---
Grand Rapids Indians	M	12	---	-.15x	---
Blood Vein Indians	M	15	---	-.04x	---
Poplar River Indians	M	27	---	-.13x	---
CALIFORNIA CHILDREN					
1 Months	MAF		.74	.65	.84	77
3 Months	MAF		.78	.78	.78	100
6 Months	MAF		.81	.79	.83	95
9 Months	MAF		.84	.78	.92	85
12 Months	MAF		.88	.78	.99	79
15 Months	MAF		.88	.84	.93	90
18 Months	MAF		.80	.80	.80	100
24 Months	MAF		.86	.80	.91	88
36 Months	MAF		.79	.78	.81	96
NEW YORK CHILDREN						
3 Years	M	15	.73	.73	.85	86
4 Years	M	21	.73	.52	.78	76
5 Years	M	23	.74	.66	.76	87
6 Years	M	19	.26	.31	.21	148
7 Years	M	21	.53	.41	.68	60
8 Years	M	14	.66	.74	.59	125
3 Years	F	11	.51	.70	.37	189
4 Years	F	20	.83	.66	1.05	63
5 Years	F	19	.53	.59	.47	126
6 Years	F	25	.50	.35	.71	49
7 Years	F	21	.80	.78	.82	95
8 Years	F	13	.73	.72	.74	97
MANCHESTER (England) GRAMMAR SCHOOL						
11 Years	M	29	.49	.44	.54	81
12 Years	M	112	.85	.80	.91	88
13 Years	M	173	.88	.79	.98	81
14 Years	M	295	.89	.87	.90	97
15 Years	M	283	.82	.84	.81	104
16 Years	M	173	.85	.91	.80	114
17 Years	M	80	.81	.89	.74	120
18 Years	M	25	.82	.84	.80	105
LONDON SCHOOL						
5-13 Years	M	215	.94	.69	1.29	53

TABLE 48 (Cont.)

x, Stature
y, Stem Length

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
WESTMINSTER SCHOOL						
12-18 Years	M	279	.92	.82	1.03	80
WORCESTER CHILDREN						
6 Years	M	105	.78	.87	.70	124
7 Years	M	142	.81	.79	.84	94
8 Years	M	120	.83	.88	.78	113
9 Years	M	167	.79	.77	.81	95
10 Years	M	157	.80	.82	.78	105
11 Years	M	151	.88	.81	.94	86
12 Years	M	177	.88	.84	.92	91
13 Years	M	168	.90	.93	.87	107
14 Years	M	154	.92	.96	.88	109
15 Years	M	152	.85	.81	.89	91
16 Years	M	96	.79	.77	.81	95
17 Years	M	49	.77	.69	.87	79
6 Years	F	84	.67	.64	.70	91
7 Years	F	101	.74	.78	.70	111
8 Years	F	105	.81	.82	.80	102
9 Years	F	118	.81	.83	.79	105
10 Years	F	160	.84	.85	.83	102
11 Years	F	152	.85	.95	.73	130
12 Years	F	165	.84	.86	.82	105
13 Years	F	142	.80	.69	.93	74
14 Years	F	115	.85	.81	.89	91
15 Years	F	109	.81	.71	.92	77
16 Years	F	91	.71	.79	.64	123
17 Years	F	69	.71	.64	.79	81

TABLE 49

x, Stature i, $\frac{y}{x}$
y, Span

Group	Sex	N	r xy	r xi	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
English, Fathers	M	1079	.78	-.12	.67	.91	74
English, Mothers	F	1079	.76	-.11	.65	.91	69
English, Sons	M	1401	.80	-.12	.70	.92	76
English Daughters	F	1401	.83	-.07	.72	.95	76
Alsop, Armenia	M	22	.75	.09	.52	1.09	87
Kazikoumouks, Caucasus	M	11	.80	.16	.57	1.13	50
Probstei, East Holstein	M	260	--	-.14	--	--	
Probstei, East Holstein	F	310	--	-.14	--	--	

TABLE 50

Lag in Traits of Sioux Indians
(Sullivan, 1925)

x, Stature
y, Sitting Height

Group	Sex	N	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio of Lags
Pure Sioux	M	536	.61	.51	.74	68
Pure Sioux	F	157	.54	.42	.70	60
Half-blood Sioux	M	77	.65	.52	.81	64
x, Stature x, Width of Shoulder						
Pure Sioux	M	534	.35	.23	.53	44
Pure Sioux	F	157	.43	.26	.77	33
Half-blood Sioux	M	77	.48	.39	.59	66
x, Stature y, Arm Reach						
Pure Sioux	M	531	.81	.68	.96	71
Pure Sioux	F	157	.83	.72	.96	74
Half-blood Sioux	M	77	.85	.87	.83	105
x, Stature y, Length of Arm						
Pure Sioux	M	532	.70	.49	.99	50
Pure Sioux	F	157	.67	.44	1.03	43
Half-blood Sioux	M	77	.76	.70	.82	85
x, Head Length y, Width of Head						
Pure Sioux	M	538	.27	.25	.30	83
Pure Sioux	F	156	.28	.18	.45	72
Half-blood Sioux	M	77	.54	.61	.48	126
x, Width of Head y, Width of Face						
Pure Sioux	M	538	.55	.52	.58	90
Pure Sioux	F	156	.49	.44	.58	82
Half-blood Sioux	M	77	.51	.43	.60	72
x, Height (Nasion to Chin) y, Width of Face						
Pure Sioux	M	534	.16	.22	.11	196
Pure Sioux	F	157	.31	.46	.21	222
Half-blood Sioux	M	77	.06	.11	.06	185
x, Nose Height y, Width of Nose						
Pure Sioux	M	536	.05	.04	.06	70
Pure Sioux	F	157	-.08	-.06	-.10	66
Half-blood	M	77	.02	.02	.02	64

WALLIS: ANATOMIC LAG

SUMMARY OF LAGS

TABLE 51A

Lag in Head Dimensions. Means of Series

S, Skulls
L, Living
N, Number of Series. Adults Unless Otherwise Indicated

No. N	F	x	y	1	Material	Age	kx	kl	r xi
7		Ear Height	Thickness Lips	y/x					-.28
5		Face Breadth	Face Height	y/x	L		-.351	-.47x	-.26
4		Face Breadth	Face Height	y/x	S		-.611	-.30x	-.36
4		Face Breadth	Head Breadth	y/x	S		.621	.19x	-.48
8		Foramen Mag. Length	Foramen Breadth	y/x	S				-.61
	2	Foramen Mag. Length	Foramen Breadth	y/x	S				-.60
5		Head Breadth	Head Length	x/y	S		.721	.48x	.64
	2	Head Breadth	Head Length	x/y	S			.54x	.72
21		Head Length	Head Breadth	y/x	L		-1.001	-.53x	-.55
	3	Head Length	Head Breadth	y/x	L		-1.321	-.26x	-.66
28		Head Length	Head Breadth	y/x	S		-1.011	-.41x	-.56
	16	Head Length	Head Breadth	y/x	S		-.861	-.53x	-.62
12		Head Length	Head Breadth	y/x	L	6-17			-.63
	12	Head Length	Head Breadth	y/x	L	6-17			-.60
5		Head Length	Head Height	y/x	S		-.521	-.78x	-.58
	3	Head Length	Head Height	y/x	S		-.451	-.83x	-.51
20		Nasal Height	Nasal Breadth	y/x	S		-.351	-.79x	-.47
	12	Nasal Height	Nasal Breadth	y/x	S		-.371	-.88x	-.50
11		Nasal Height	Nasal Breadth	y/x	L		-.861	-1.26x	-.52
7		Nose Breadth	Interpupillary Dist.	y/x	L				-.32
7		Nose Breadth	Thickness Lips	y/x	L				-.23
7		Nose Breadth	Ear Height	y/x	L				-.49
9		Orbital Breadth	Orbital Height	y/x	L		-.201	-1.18x	-.45
	6	Orbital Breadth	Orbital Height	y/x	L		-.111	-.78x	-.34
6		Palate Length	Palate Breadth	y/x	L		-.391	-1.91x	-.70
	2	Palate Length	Palate Breadth	y/x	L				-.50

TABLE 51B

Lag in Head Dimensions

No. N	F	x	y	Material	Age	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Means
7		Ear Height	Thickness Lips	L		.04	.28	14
5		Face Breadth	Face Height	S		.25	.43	58
	4	Face Breadth	Face Height	S		.19	.60	31
10		Face Breadth	Face Height	L		.21	.27	78
6		Face Breadth	Min. Frontal Br.	L		.45	.61	74
4		Face Breadth	Min. Frontal Br.	S		.39	.45	87
	2	Face Breadth	Min. Frontal Br.	S		.35	.35	100
7		Face Breadth	Head Breadth	L		.63	.73	73
4		Face Breadth	Head Breadth	S		.56	.46	122
13		Head Breadth	Head Height	L		.27	.33	82
6		Head Breadth	Head Height	S		.28	.30	93
	7	Head Breadth	Head Height	S		.30	.33	91
6		Head Breadth	Min. Frontal Br.	S		.26	.40	65
	3	Head Breadth	Min. Frontal Br.	S		.25	.31	81
5		Head Length	Face Height	S		.14	.34	41
5		Head Length	Min. Frontal Br.	S		.22	.53	42
4		Head Length	Face Height	S		.16	.62	26
4		Head Length	Face Breadth	S		.28	.41	69
15		Head Length	Head Breadth	L		.34	.38	89
12		Head Length	Head Breadth	L	6-17	.22	.22	100
32		Head Length	Head Breadth	L	6-17	.27	.28	96
		Head Length	Head Breadth	L		.29	.33	88
	6	Head Length	Head Breadth	L			.21	
6		Head Length	Head Breadth	S		.10	.14	71
	6	Head Length	Head Breadth	S		.13	.16	81
14		Head Length	Head Height	L		.30	.40	75
	2	Head Length	Head Height	L				
5		Head Length	Head Height	S		.28	.36	78
	7	Head Length	Head Height	S		.30	.30	100
6		Horizontal Circum.	Head Length	L		.67	1.01	66
	1	Horizontal Circum.	Head Length	L				
7		Nose Breadth	Interpupillary Dist.	L		.50	.15	333
7		Nose Breadth	Thickness Lips	L		.14	.15	95
7		Nose Breadth	Ear Height	L		.24	.12	200

TABLE 51C

Body Dimensions. Means of Series

No. N	F	x	y	Material	Age	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Means
12		Head Length	Weight	L	6-17	.10	1.82	5
	12	Head Length	Weight	L	6-17	.10	1.72	6
12		Head Width	Weight	L	6-17	.08	1.19	6
	12	Head Width	Weight	L	6-17	.08	1.80	5
22		Humerus	Femur	S		.86	.83	104
6		Arm Length	Trunk Length	L		.35	.30	119
	1	Arm Length	Trunk Length	L		.56	.28	122
6		Arm Length	Leg Length	L		.70	.86	81
	1	Arm Length	Leg Length	L		.50	.67	75
8		Radius	Humerus	S		.94	.77	122
5		Shoulder Br.	Pelvic Breadth	L		.31	.47	66
6		Shoulder Br.	Pelvic Breadth (N.Y. Children)	L	3-8	.84	.52	162
	6	Shoulder Br.	Pelvic Breadth (N.Y. Children)	L	3-8	.60	.59	102
12		Sitting Ht.	Weight	L	6-17	.85	2.61	10
	12	Sitting Ht.	Weight	L	6-17	.22	2.22	10
12		Sitting Ht.	Head Length	L	6-17	.43	.23	187
	12	Sitting Ht.	Head Length	L	6-17	.45	.24	188
12		Sitting Ht.	Head Width	L	6-17	.35	.18	194
	12	Sitting Ht.	Head Width	L	6-17	.32	.16	200
9		Stature	Arm Length	L		.84	.91	70
	3	Stature	Arm Length	L		.48	.88	44
6		Stature	Arm Length (Radius)	L	3-8	.56	1.30	43
	6	Stature	Arm Length (Rad)	L	3-8	.49	1.42	34

TABLE 51C (Cont.)

Body Dimensions. Means of Series.

No. N	F	x	y	Material	Age	r xy (Yx/Yy)	r xy (Yy/Yx)	Ratio of Means
16		Stature	Chest Circum.	L		.46	.66	73
6		Stature	Head Breadth	L		.22	.165	133
11		Stature	Head Height	L		.22	.26	85
12		Stature	Weight	L	6-17	.25	2.39	10
	12	Stature	Weight	L	6-17	.23	2.28	10
12		Stature	Sitting Height	L	6-17	.83	.84	99
	12	Stature	Sitting Height	L	6-17	.78	.79	99
12		Stature	Head Length	L	6-17	.46	.26	185
	12	Stature	Head Length	L	6-17	.45	.24	188
12		Stature	Head Width	L	6-17	.33	.18	183
	12	Stature	Head Width	L	6-17	.30	.15	200
18		Stature	Head Length	L	18-22 & Adults	.34	.26	131
4		Stature	Head Circum.	L	20-40	.34	.16	212
	4	Stature	Head Circum.	L	20-40	.30	.10	286
6		Stature	Leg Length *	L	3-8	.72	1.07	67
	6	Stature	Leg Length *	L	3-8	.61	.87	70
21		Stature	Leg Length	L	18-22	.63	1.22	52
5		Stature	Pelvic Breadth	L		.346	.79	44
6		Stature	Pelvic Breadth	L	3-8	.68	.77	88
	6	Stature	Pelvis Breadth	L	3-8	.49	.80	61
5		Stature	Shoulder Br.	L		.38	.57	67
6		Stature	Shoulder Br.	L	3-8	.65	1.14	57
	6	Stature	Shoulder Br.	L	3-8	.48	.78	62
5		Stature	Span	L		.62	1.01	61
	3	Stature	Span	L		.68	.93	73
10		Stature	Stem Length	L		.60	.79	65
6		Stature	Stem Length	L	3-8	.57	.64	89
	6	Stature	Stem Length	L	3-8	.53	.60	91
10		Stature	Stem Length	L	9-18	.79	.88	90
8		Tibia	Femur	S		1.05	.73	144
10		Tibia	Humerus	S		.90	.78	116
6		Tibia	Radius	S		.79	.80	99
5		Trunk Length	Pelvic Breadth	L		.876	.56	79
5		Trunk Length	Shoulder Breadth	L		.29	.25	118
5		Trunk Length	Leg Length	L		.18	.19	97

*Tibiale to Heel

TABLE 52A

Sex Difference in Lag in Adults and During Growth.
Means of Series. Based on Preceding Tables ( )
Indicates Greater Acceleration. Ratio is Lag of x/Lag of y. Greater Lag Means Lower Relative Regression Coefficient.

Dimensions Paired x	y	Age	Age of Greater Lag Males x	Age of Greater Lag Males y	Age of Greater Lag Females x	Age of Greater Lag Females y	Ratio M - F
Head Length	Head Breadth	Ad.				.02	
Head Length	Head Breadth	Ad.		.02			- 10
Head Length	Head Breadth	6-17	.05	.06			08
Face Breadth	Face Height	Ad.		.17	.06		27
Face Breadth	Min. Frontal Breadth	Ad.			.04	.10	- 13
Head Breadth	Head Height	Ad.	.02	.03			02
Head Breadth	Min. Frontal Breadth	Ad.			.01	.09	- 16
Head Length	Head Height	Ad.	.02			.06	- 22
Arm Length	Trunk Length	Ad.	.01			.02	- 09
Arm Length	Leg Length	ad.			.20	.19	06
Rhoulder Br.	Pelvic Br.	3-8		.07	.28		60
Stature	Arm Length	Ad.			.16	.03	16
Stature	Arm Length	3-8			.07	(.12)	09
Stature	Weight	6-17		(.11)	.02		00
Stature	Sitting Ht.	6-17			.05	.05	00
Sitting Ht.	Weight	6-17		(.39)	.03		00
Stature	Head Length	6-17			.03	.02	- 03
Stature	Head Width	6-17			.03	.03	- 01
Sitting Ht.	Head Length	6-17	.02	.01			- 01
Sitting Ht.	Head Width	6-17		.03	.02		- 04
Head Length	Weight	6-17		(.10)			- 01
Head Width	Weight	6-17				(.11)	01
Stature	Head Circum.	20-40			.04	.06	- 04
Stature	Leg Length	3-8			.11	.20	- 07
Stature	Pelvic Br.	3-8		.03		.19	- 07
Stature	Shoulder Br.	3-8			.17	.36	- 05
Stature	Span	Ad.	.06			.08	- 12
Stature	Stem Length	3-8	.06	.05			- 02
Total		Ad.	.11	.22	.51	.65	-105
Total, Acceleration Omitted		3-8	.06	.15	.69	.75	86
Total, Acceleration Omitted		6-17	.07	.07	.19	.12	- 23
Grand Total, Acceleration Omitted		All Ages	.24	.44	1.29	1.52	- 42

TABLE 52B

Sex Differentials in Relative Regression Coefficients and in Their Ratios.
By Age, Worcester Males and Females ( ), Acceleration

x	y	Relative Regression Coefficients r xy (Yx/Yy) M>F	M<F	M=F	r xy (Yy/Yx) M>F	M<F	M=F	Ratio M>F	M<F	M=F
(Stature)	Weight	6-7 9-10 13-15	8, 11, 17	12	6-7 11-12 14-16	8-10 13,17		6, 9-10 13-15 17	7-8 11-12 16	
Stature	Sitting Height	6-8 13-15 17	9-12 16		7, 9 11-12 16-17	8, 10 13-15	6	6, 8 10 13-15	7, 9 11-12 16-17	
(Sitting Height)	Weight	6-7 9-11 13-15 17	8, 16	12	6-7 11-13 15-17	8-10 14		7, 9-10 14, 17	8, 11, 13, 16	6, 12, 15

SUMMARY OF LAGS

TABLE 52B
(Cont.)

Sex Differentials in Relative Regression Coefficients and in Their Ratios.
By Age, Worcester Males and Females ( ), Acceleration.

x	y	Relative Regression Coefficients											
		r xy(Vx/Vy)			r xy (Vy/Vx)			Ratio		
		M > F	M < F	M=F	M > F	M < F	M=F	M > F	M < F	M=F
Stature	Head Length	6 8-9 14-16	7 10-13 17		6-9 11-12 15-16	10 13-14 17		9 13-15	6-8 10-12 16-17	
Stature	Head Width	7-10 13 15-17	6 11-12 14		7-11 15-17	6 12 14	13	9 13-16	6-8 10-12 17	
Sitting Height	Head Length	6 8-9 14-15 17	7 10-13 16		6-8 15 17	10-14 16	9	9-10 13-17	6-8 11 12	
Sitting Height	Head Width	7-9 11 15 17	6 10 12-14 16		7-11 15 17	6 12-14 16		9 14-16	6-8 10-13 17	
(Head Length)	Weight	6 8 10-12 14-16	7 9 13 17		6 8 10-12 14-16	7 9 13 17		6 7 9-11 17	8 13 15-16	12 14
(Head width)	Weight	6 9-11 15	7-8 13-14 16	12 17	9 11 15-16	6-8 10 12-14 17		6-10 12 17	13-16	11
Head Length	Head Weight	7 12	8 10-11 13-17	6 9	7 12	9-11 13-17	6 8	9 11 14-16	8 10 12-13 17	6-7

TABLE 53A

Worcester, Massachusetts, School Children
Summary for All Ages (6-17)
(Boas & Wissler. 1904)

x	y	r xy	r xy (Vx/Vy)	r xy (Vy/Vx)	Ratio	Boys-Girls Relative Regression Coefficients r xy (Vx/Vy)
			BOYS			
Stature	Weight	.77	.25	2.39	10	.02
Stature	St. Ht.	.83	.83	.84	99	.04
St. Ht.	Weight	.74	.25	2.61	10	.03
Stature	Head L.	.42	.48	.26	185	.03
Stature	Head W.	.24	.33	.18	183	.03
St. Ht.	Head L.	.31	.43	.23	187	-.02
St. Ht.	Head W.	.09	.35	.18	194	.03
Head L.	Weight	.36	.10	1.82	5	-.00
Head W.	Weight	.32	.08	1.39	6	.00
Head L.	Head W.	.22	.22	.22	100	-.05
			GIRLS			(Vy/Vx)
Stature	Weight	.72	.23	2.28	10	.11
Stature	St. Ht.	.78	.78	.79	99	.05
Sitting Ht.	Weight	.70	.22	2.22	10	.39
Stature	Head L.	.32	.45	.24	185	.02
Stature	Head W.	.21	.30	.15	200	.03
St. Ht.	Head L.	.32	.45	.24	188	-.01
St. Ht.	Head W.	.22	.32	.16	200	.02
Head L.	Weight	.40	.10	1.72	6	.10
Head W.	Weight	.34	.08	1.50	5	-.11
Head L.	Head W.	.27	.27	.28	96	-.06

TABLE 53B

Influence on Lag of Holding Age Constant. Worcester Males (Boas & Wissler).
Age in Month Constant for Each Year Interval. Correlations with Age by A. S. Moe.
Vx/Vy, Relative Regression Coefficient, (i.e., Multiplied by r xy); (A), Age in Month Constant.

Age x - y	6-6.11			7-7.11			8-8.11			9-9.11			Mean		
	r xy	Vx/Vy	Vy/Vx	r xy	Vx/Vy	Vy/Vx	r xy	Vx/Vy	Vy/Vx	r xy	Vx/Vy	Vy/Vx	Vx/Vy	Vy/Vx	r
Stature-Weight	.86	.39	1.91	.78	.28	2.17	.69	.85	1.92	.72	.85	2.06	.29	2.02	.76
Stature-Weight (A)	.89	.40	1.98	.78	.28	2.17	.67	.84	1.86	.69	.84	1.97	.29	2.00	.76
r-r (A)	-.03	-.01	-.07	00	00	00	.02	.01	.06	.03	.01	.09	.002	.02	.01
Stat. St. Ht.	.78	.87	.70	.81	.79	.84	.83	.88	.78	.79	.77	.81	.83	.78	.80
Stat. St. Ht. (A)	.78	.87	.70	.80	.78	.82	.84	.88	.78	1.00	.98	1.02	.88	.83	.86
r-r (A)	00	00	00	.01	.01	.02	-.01	-.00	-.00	-.21	-.21	-.21	-.05	-.05	-.05
Sitting Ht.-Wt.	.77	.31	1.92	.79	.29	2.14	.52	.18	1.53	.70	.25	1.94	.26	1.88	.70
Sitting Ht.-Wt. (A)	.79	.32	1.98	.78	.29	2.11	.51	.17	1.50	.67	.25	2.09	.28	2.07	.76
r-r (A)	-.02	-.01	-.06	.01	.00	.03	.01	.01	.03	-.27	-.10	-.65	-.02	-.19	-.07
Stat.-Head L.	.30	.43	.21	.36	.43	.30	.44	.61	.32	.41	.51	.33	.50	.29	.38
Stat.-Head L. (A)	.30	.43	.21	.35	.42	.29	.42	.59	.30	.38	.47	.30	.48	.28	.36
r-r (A)	00	00	00	.01	.01	.01	.02	.02	.02	.03	.04	.03	.02	.02	.02
Stat.-Head Width	.20	.30	.13	.27	.35	.20	.19	.25	.15	.23	.30	.17	.30	.16	.22
Stat.-Head Width (A)	.20	.30	.13	.24	.31	.18	.19	.25	.15	.23	.30	.17	.29	.16	.22
r-r (A)	00	00	00	.03	.04	.02	00	00	00	00	00	00	.01	.01	.01
St. Ht.-Head L.	.34	.44	.27	.38	.46	.31	.45	.59	.34	.37	.47	.29	.49	.30	.38
St. Ht.-Head L. (A)	.34	.44	.27	.37	.44	.31	.46	.60	.35	.52	.66	.42	.53	.34	.42
r-r (A)	00	00	00	.01	.02	.00	-.01	-.01	-.01	-.15	-.18	-.13	-.04	-.04	-.04
St. Ht.-H W.	.24	.32	.18	.29	.39	.21	.30	.37	.25	.29	.39	.22	.37	.22	.28
St. Ht.-H W. (A)	.24	.32	.18	.24	.32	.18	.30	.37	.25	.30	.40	.22	.35	.21	.27
r-r (A)	.00	.00	.00	.05	.07	.03	.00	.00	.00	-.01	-.01	.00	.02	.01	.01
Head L.-Weight	.46	.14	1.46	.41	.12	1.37	.46	.12	1.77	.39	.11	1.39	.12	1.50	.43
Head L.-Weight (A)	.41	.13	1.32	.41	.12	1.37	.43	.11	1.67	.48	.13	1.71	.12	1.51	.43
r-r (A)	.05	.01	.16	.00	.00	.00	.03	.01	.12	-.09	-.02	-.32	.0	-.01	.00
Head Width-Wt.	.40	.12	1.33	.20	.05	.74	.25	.07	.88	.40	.11	1.48	.09	1.11	.31
Head Width-Wt. (A)	.36	.11	1.20	.16	.04	.59	.26	.07	.93	.41	.12	1.52	.08	1.06	.30
r-r (A)	.04	.01	.13	.04	.01	.15	-.01	.00	-.04	-.01	.00	-.04	.01	.05	.01
Head Lg.-Head W.	.30	.31	.20	.18	.20	.16	.14	.13	.15	.25	.31	.27	.24	.22	.23
Head Lg.-Head W. (A)	.25	.26	.24	.15	.16	.14	.16	.16	.17	.29	.31	.27	.22	.20	.21
r-r (A)	.05	.05	.05	.03	.04	.02	-.02	-.02	-.02	.00	.00	.00	.02	.02	.02

LAGS IN LOWER ANIMALS

TABLE 54

Lag in Eupagurus Prideauxi
(Schuster, Biometrika, 2:195, 210)

x_1 Measurement No. 1 $i_1, \frac{x_1}{x_1}$. x_2 Right Chela Length $i_2, \frac{x_2}{x_2}$

x_3 Carapace Length $i, \frac{x_2 - x_1}{x_2}$

	Male		Female	
	Deep Sea	Shallow	Deep Sea	Shallow
N	483	550	470	554
r x_1x_3	.95	.93	.85	.84
r x_1i_1	-.85	-.81	-.49	-.47
r x_2x_3	.94	.95	.86	.88
r x_2i_2	-.78	-.77	-.45	-.38
r x_3i_3	-.52	-.44	"Insensible"	"Insensible"

TABLE 55

Paramecium (Pearl, Biometrika, 5:161, 64, 225-240, 1906-07)

x, Length of Body
y, Breadth of Body $i, \frac{y}{x}$

Series	Group	No.	r xy	r xy(Vx/Vy)	r xy(Vy/Vx)	r xi	r yi
A	Non-conjugants	210	.59	.44	.79	-.16	.37
	Conjugants	210	.28	.20	.39	-.41	.69
B	Non-conjugants	132	.08	.03	.73	-.33	.39
AA	Conjugants A	200	.40	.25	.66		
	Conjugants B	200	.37	.21	.66		
C	Conjugants	202				-.60	.61
	Non-conjugants	202				-.27	.39
A	Unfavorable Conditions	207	.68	.68	.68	-.45	.41
B	Favorable Conditions	175	.62	.68	.56	-.39	.43

TABLE 56

Young Trout, at Intervals of Four Weeks of Age

$i, \frac{y}{x}$

x	y	Stage I r xy	Stage I r xi	Stage III r xy	Stage III r xi	Stage V r xy	Stage V r xi	Stage I r xy	Stage I $\frac{Vx}{Vy}$	Stage I r xy	Stage I $\frac{Vy}{Vx}$	Stage III r xy	Stage III $\frac{Vx}{Vy}$	Stage III r xy	Stage III $\frac{Vy}{Vx}$	Stage V r xy	Stage V $\frac{Vx}{Vy}$	Stage V r xy	Stage V $\frac{Vy}{Vx}$
Total Length	Breadth Caudal Fin	.89	.69	.74	.51	.73	.38	.40	1.98			.84	2.84			.32	1.64		
Total Length	Breadth of Body	--	--	.790	.326	.87	.15	--	--			.48	1.36			.69	1.10		
Total Length	Length Ant. Dorsal Fin	.76	.260	.493	.192	.60	-.58	.45	1.89			.16	1.53			.78	.50		
Total Length	Length Ventral Fin	.84	.61	.584	.369	.61	.03	.34	2.05			.15	2.23			.32	1.17		
Total Length	Length Post. Dorsal Fin	.45	.08	.452	.119	.52	.08	.21	1.16			.15	1.32			.24	1.13		
Total Length	Length of Head	.94	.65	.729	-.071	.85	-.51	.61	1.40			.57	.94			1.02	.71		
Length of Head	Diameter of Eye	.77	-.47	.646	-.564	.65	-.63	.26	.70			.78	.54			.84	.50		
Length Anterior	Posterior Dorsal Fin	.43	-.31	.441	-.574	.39	-.00	.12	.60			.48	.40			.15	1.00		
Length Ventral	Posterior Dorsal Fin	.52	-.53	.646	-.659	.58	-.34	.28	.52			.84	.50			.50	.65		
Position of Pectoral	Pelvic Fin	.87	-.90	.691	-.629	.82	-.28	.87	.46			.90	.53			.81	.83		

TABLE 57

Brittle Star (Ophiocoma Nigra)
(Biometrika, 2:370, 1902-03)

N, 1000

r Arm Length (x) - Disc Br. (y)	r $x\frac{y}{x}$	r xy(Vx/Vy)	r xy(Vy/Vx)
.93	-.31	.98	.89

TABLE 58

Fiddler Crab (Duncker, Biometrika, 2)

Gh, Miropoditenlänge des Scherenpaares
d, Miropoditenlänge des Gangbeinpaares
c, Carpopoditenlänge des Scherenpaares
p, Propoditenlänge des Scherenpaares
N, About 400
s, Left Side
d, Right Side

	x	y	r xy	r xi	r xy(Vx/Vy)	r xy(Vy/Vx)
Righthanded	Ge	Chs	.80	-.84	.76	.84
		Chd	.83	-.84	.80	.85
	Gd	Chs	.80	-.31	.79	.80
		Chd	.84	-.50	.85	.84
	Fs	Cs	.62	-.41	.60	.64
		Cd	.66	-.43	.54	.69
	Fd	Cs	.60	-.43	.59	.61
		Cd	.84	-.24	.81	.86
Lefthanded	Ge	Chs	.85	-.30	.86	.84
		Chd	.80	-.34	.81	.79
	Gd	Chs	.83	-.84	.81	.86
		Chd	.80	-.28	.78	.82
	Fs	Cs	.84	-.28	.84	.84
		Cd	.64	-.32	.57	.71
	Fd	Cs	.62	-.49	.66	.58
		Cd	.65	-.38	.62	.68

TABLE 59

Skull and Bones of the Nebraska Muskrat
125 Individuals
(Latimer & Riley, J.of Morph.,56:205,208, 1934)

$i, \frac{y}{x}$

	r xy	r xi	r xy(Vx/Vy)	r xy(Vy/Vx)
x, Skull Length y, Dimension				
Basilar	.95	.15	.86	1.06
Nasals	.81	.28	.52	1.27
Palatine Slits	.49	.11	.19	1.29

TABLE 59
(Cont.)

Skull and Bones of the Nebraska Muskrat
125 Individuals

	r xy	r xi	r xy(Vx/Vy)	r xy(Vy/Vx)
x, Skull Length y, Dimension				
Postpalatal	.79	.06	.59	1.05
Fronto-occipital	.72	-.34	.70	.74
Maxillary Teeth	.64	-.57	.60	.68
Diastema	.84	.28	.58	1.22
Mandible	.86	-.19	.83	.90
Breadth	.47	-.73	.66	.34
Bizygomatic	.78	-.07	.61	.95
Interorbital	.53	-.13	.34	.83
Biparietal	-.29	-.67	.14	.29
Humerus	.82	.10	.61	1.08
Radius	.80	.10	.59	1.04
Ulna	.74	-.19	.64	.95
Femur	.82	.20	.58	1.16
Tibia	.82	.08	.63	1.06
x, Biparietal Diameter y, Dimension				
Head Breadth	.14	-.89	.28	.07
Interorbital	.08	-.84	.07	.01
Palatine Slits	.005	-.49	.003	.001
Maxillary Teeth	-.18	-.84	-.23	-.13
x, Skull Weight y, Wts.of other Parts of Body				
Mandible	.93	-.74	1.84	.70
Humerus	.82	-.01	.66	.99
Radius & Ulna	.78	-.005	.62	.99
Femur	.84	-.01	.69	1.01
Tibia	.87	-.02	.77	.99

TABLE 60

12 Turkey Hens

(Latimer, Anat. Rec., 34:17-23, 1926; 35:365-375, 1927)

x, Length of Body y, Length of	$i, \frac{y}{x}$			
Humerus	.77	-.77	1.16	.51
Radius	.65	-.88	1.36	.51
Ulna	.78	-.87	1.44	.60
Femur	.66	-.78	1.32	.33
Tibia	.83	-.77	1.24	.66
Tarsometatarsus	.89	-.85	1.42	.56
Wing	.82	-.72	.87	.44
Head(width)	.27	-.94	.76	.95
Leg	.91	-.87	1.46	.57

TABLE 61

LAGS IN LOWER ANIMALS

Correlation and Lags of Body Weight (x) with Weights of Various Organs and Parts of the Body (y) in 12 Turkey Hens.

1 is y/x

(Latimer, Anatomical Record, 34:17-23, 1926; 35:366-375, 1927.)

Weight (y) of:	r xy	r xi	r xy (Vx/Vy)	r xy (Vx/Vy)
Eyeballs	.87	-.75	1.22	.62
Heart	.85	-.24	.83	.87
Integument	.85	.22	.62	1.16
Musculature	.83	-.14	.76	.91
Empty Digestive Tract	.81	-.73	1.13	.58
Ligamentous Skeleton	.80	-.70	1.12	.57
Kidneys	.79	.24	.51	1.23
Liver	.75	.45	.31	1.79
Spinal Cord	.73	-.67	1.46	.36
Head	.71	-.90	1.56	.32
Suprarenals	.69	.27	.34	1.41
Brain	.61	-.97	2.20	1.69
Spleen	.48	.26	.12	.20
Oviduct	.43	.32	.06	3.31
Ovary	.40	.30	.04	3.64
Pancreas	.25	-.33	.15	.42
Lungs & Trachea	.20	-.22	.08	.48
Hypophysis	-.07	-.56	-.04	-.11
Feathers	-.21	-.82	-.25	-.18
Thyroid	-.56	-.75	-.21	-1.47
Thymus	-.60	-.69	-.10	-3.75

TABLE 62

Weights of Organs of 119 Male Turtles, and 29 Male and Female Frogs

(Latimer, Anatomical Record, 19:347-360, 1920)

1, $\frac{y}{x}$		Male Turtles				Male & Female Frogs			
x	y	r xy	r xi	r xy(Vx/Vy)	r xy(Vy/Vx)	r xy	r xi	r xy(Vx/Vy)	r xy(Vy/Vx)
Body Weight	Digestive Tract	.79	-.02	.64	.98	.87	.54	.47	1.60
Body Weight	Liver	.63	.12	.34	1.17	.84	.50	.45	1.57
Body Weight	Kidneys	.61	-.03	.39	.96	.86	.26	.63	1.18
Body Weight	Heart	.54	-.45	.52	.55	.66	.62	.41	1.07
Body Weight	Spleen	.43	.17	.12	1.55	-.06	-.35	-.02	-.20
Body Weight	Pancreas	.39	-.03	.16	.94	.91	.67	.48	1.71
Body Weight	Lungs	.16	-.23	.06	.40	.73	.17	.45	1.19
Body Weight	Testes	.09	-.22	.03	.29	--	--	--	--
Liver	Spleen	.73	.30	.38	1.42	.00	-.50	--	--
Kidneys	Liver	.65	-.26	.55	.76	.65	-.11	.48	.88
Liver	Pancreas	.63	-.18	.48	.82	.66	-.40	.65	.67
Digestive Tract	Kidneys	.62	-.21	.49	.79	.88	-.70	1.18	.65
Digestive Tract	Liver	.36	-.32	.24	.54	.72	-.36	.72	.73
Digestive Tract	Spleen	.25	-.09	.09	.74	.86	.48	.50	1.48
Kidneys	Lungs	.23	-.37	.14	.37	-.02	-.66	-.02	-.03
Heart	Digestive Tract	.25	-.52	.21	.30	.53	-.38	.46	.61
Heart	Lungs	.14	-.26	.06	.35	.40	-.55	.39	.40
Pancreas	Spleen	.45	-.24	.30	.68	-.11	-.58	-.06	-.18

SUMMARY ANALYSIS OF LAGS

A summary of lags of various compared dimensions, in which values for males are given for 4 or more series, is presented in the accompanying tables. The following observations are based on that summary, and on preceding tables.

HEAD AND SKULL

Face breadth does not show the usual lags when correlated with index $\frac{\text{Head width}}{\text{Face breadth}}$ for means of racially homogeneous groups, but is positively correlated with the index (Peruvians; Eskimo). Face breadth is positively correlated with $\frac{\text{Nasal breadth}}{\text{Face breadth}}$ in 7 series, negatively correlated in 7 series. There is negative correlation in the two large Egyptian series.

There is marked lag in face height-face breadth, both intergroup and intragroup, the lag in every instance being greater in face breadth. In the living, face breadth lags more on minimum frontal diameter than conversely; in skulls, however, in 3 of 6 series minimum frontal diameter shows the greater lag. Similarly, in the living, face breadth lags on head breadth more than conversely in 6 of 7 series; whereas in skulls the reverse applies to 5 of 6 series. In three series of means of homogeneous groups (1 Peruvian, 2 Eskimo series) there is positive correlation of face breadth with head breadth/face breadth, thus indicating less lag of head breadth than of face breadth. Face breadth lags less on head height and head length than conversely, except in Egyptian males and in a series of ethnic groups of both sexes combined.

Face height shows less lag on head height, head length, and head breadth than conversely, including ethnic group means.

Minimum frontal breadth lags less on head height and head length than conversely, except for ethnic group means.

Face height-nose height show almost equivalent mutual lags.

Basion-alveon diameter lags much more on face height than conversely.

In the living head breadth lags more on head height than conversely in all European series, and less than head height in all Negro and Negro hybrid series. In skulls, European and Egyptian series, the relationship found in European living is reversed.

In the large number of living groups for which head length and breadth are given, lag of breadth on length is less than lag of length on breadth, except in 3 groups of Orensteen's series of living Egyptians in which there is no differential in lag of breadth-length. A given percentage change in breadth, therefore, influences cranial index more than does an equivalent percentage change in length. In the series of ancient Egyptian skulls (Pearson and Davin), Tenerife (Hooton) and Macdonell's series of 3000 living English males lag of length on breadth is greater than the converse. This differential in skull and head lags in adults seems, therefore, to be well established for large series. The mean positive correlation of head breadth with cephalic index is higher than the mean negative correlation of head length with cephalic index. This differential in coefficient of correlation of respective dimension with index corresponds with the differential in lag. In only 4 of the 44 series analysed does head breadth show greater lag than head length. Two of these 4 series contain each 25 observations or less; the others are means of ethnic groups.

In most series of skulls head breadth lags more on minimum frontal diameter than conversely; but the opposite applies to Merovingian males and ethnic group means. Head breadth lags much less on head circumference than conversely; head length, however, shows less lag on head circumference; indeed

often shows acceleration. Transverse and sagittal arcs lag less on horizontal circumference than horizontal circumference on either of them. Otherwise, with the exception of skull length, sagittal arc lags more against each of 9 dimensions than any of these on sagittal arc. In the living, head height lags less on head length than conversely in all European series; the reverse is the case in 4 of 6 Negro and Negro hybrid series. In skulls, including means of ethnic groups, height has the lesser lag, with the exception of a small Andamanese series and three Pecos Indian series.

Nasal breadth lags less on nasal height than conversely, except in Pecos males, in skulls; in the living, Negro and Negro hybrids, nasal breadth shows less lag than inter-pupillary distance or ear height; but greater lag than thickness of lips, except in 1 series.

Ear height and thickness of lip show no consistent type of differential in lag, the ratio ranging from 12 to 200. The lags, which are very great for ear height, range from -.05 to .18; whereas they range from -.40 to 1.00 in thickness of lips.

Orbital breadth lags more on orbital height than conversely. In the Egyptian series palate breadth lags less on palate length than the converse; the reverse applies to Pecos Indians.

BODY DIMENSIONS

Tibia is slightly accelerated on femur, the latter consistently lagging on tibia (.66-.80); and lags less upon humerus than humerus upon tibia. There is approximately the same amount of lag of tibia on radius as of radius on tibia. Humerus lags less on radius than conversely; but more on femur than conversely, though the reverse occurs in several series. Forearm length lags more on foot length and finger length than conversely; and foot length lags more on finger length than conversely. Dimension of bones of the finger, and total finger length show several differentials in lags, for details of which the table should be consulted. Length of right second digit lags on lengths of 3rd, 4th, and 5th, whereas each of these is accelerated upon right second finger length. Right 3 is accelerated upon right 4 and 5, and right 4 upon right 5.

Weights in the bones of the hand show some differentials in lag. Lesser multangular and pisiform show less lag than any of the compared bones against these. Fifth distal phalanx lags considerably against each other distal phalanx, the latter showing considerable acceleration on fifth distal.

Head circumference lags more on head height, stem length, arm length, and leg length, than any of these on head circumference, the ratios ranging from 30 to 40. Arm length lags on leg length more than leg length on arm length, ratios ranging, in large series, from 75 to 85. Arm length lags less on trunk length than conversely, ratios ranging from 110 to 134. Leg length lags less on trunk length than the converse, although there is little difference, the ratios ranging from 88 to 102. The lags in trunk length--leg length are approximately double those in arm length--trunk length and four times those in arm length-leg length (all large series). Pelvic breadth lags less on shoulder breadth and trunk length than conversely, the ratios ranging from 62 to 71 for shoulder breadth, and from 76 to 83 for pelvic breadth. Lag of shoulder breadth on pelvic breadth is very nearly the same as lag of arm length on trunk length. Pelvic breadth lags more on trunk length than on shoulder breadth. Shoulder breadth lags more on trunk length than conversely (ratios 106-123).

Arm length lags on stature less than stature on arm length; in fact, the series show no lag in arm length, and 1 series shows a slight acceleration of arm length. Ratios range from 54 to 89.

Coefficients of correlation of stature with arm length/stature range from

-.25 to .21; and of stature with leg length/stature from -.25 to .29.

When the index is $\frac{\text{dimension}}{\text{stature}}$, stature is positively correlated with index in the case of femur, femur plus tibia, foot length, hand length, tibia length. It is negatively correlated with index in the case of forearm length, foot breadth, head length, head module, shoulder breadth, span, sitting height. Stature lags on leg length, and lags on forearm length more than forearm length lags on stature. Stature shows the greater lag when paired with arm length, chest circumference, finger length, foot length, cranial capacity (means of groups), leg length, pelvic breadth, shoulder breadth, sitting height, stem length, span; *stature shows the lesser lag* when paired with head breadth (including means of ethnic groups), excepting in Pure Sioux, head length, face breadth, face length, *(means of Russian groups, MF), head circumference; there is no consistent* differential relative lag for stature-head. height.

Bardeen finds that in adults relative sitting height varies inversely as the cube root of stature. That is, $\frac{100(\text{S.H.}^{1/3})}{\text{Stature}} = k$ (a constant). The constant has differential group values. He uses means of stature and sitting height for the entire group in deriving his constant. "This constant, determined for a given race, sex, and age period makes a convenient index of relative sitting height." (Am. J. Phys. Anthropol., 6:355, 1923).

SEX DIFFERENCES IN LAG

In the Egyptian series of Pearson and Davin (Biometrika 16, 1924) there appear to be few significant sex differences in values of r xi, with the exception of transverse arc-zygomatic breadth, which shows less lag in females than in males. Males have a lower value of coefficient than females in 36 of 71 instances. The greatest sex difference in r xi is .272. In only four other instances is the sex difference as great as .1. Mean excess of males over females in 71 correlations is .004(r xi).

There are significant sex differences in some ratios of lag in this series. Thus dimensions have a higher ratio of lag on maximum length of skull in males than in females in all 9 instances, with the greatest difference in ratio of lag of bizygomatic breadth-skull length. In dimensions paired with skull breadth the ratio is lower in males in 6 pairs, higher in 1, and the same as in females in 1, the greatest differential being with basio-bregmatic height and auricular height. Ratio of dimensions with bizygomatic breadth is lower in males in all instances, the greatest differential being with basio-bregmatic height and auricular height. Dimensions paired with horizontal circumference have higher ratio in males in 4 pairs, lower in 1. Other dimensions show higher ratios of lag against sagittal arc in males than in females in 9 of 10 instances. Relative regression coefficients, therefore, reveal certain sex differentials in lag which are not disclosed by the correlation of dimension with index (r xi). Inspection shows that there is no consistent relation between relative amount of lag and ratio for the sexes in a given pair of dimensions. That is, the sex having the higher ratio may or may not have the greater amount of lag. Mean excess of male ratio of lags over female in 71 paired dimensions is 2.32. In 71 comparisons males have a mean lag of x dimensions of .317, and of y dimensions of .434. The corresponding values for females are .299 and .423. Thus females show slightly greater mean lag than males in this series. Though the differences are small, the numbers in each series are large (700 M, 400 F) and the mean difference is probably statistically significant. (Mean coefficient of correlation of dimensions (r xy) is slightly higher in males than in females in this series).

Table 52A, giving means of series, indicates that in adults females more frequently than males show the greater lag (lower coefficient of relative regression). The total greater lag, for paired dimensions listed in this table, are almost five times as great in females for x lags, and nearly three times as great for y lags. For the age group 3-8 the greater x lags in females total almost ten times the value of greater x lags in males, the y lag excess in females is five times the y lag excess in males. For the age group 6-17 the respective values in females are approximately three times and two times the value in males. It seems clear, therefore, that when total analyses are considered, females show greater lag than males, both during growth, at year intervals, and as adults.

The total ratio of lags is less in males than in females, for ages 6-17 and for adults, but is greater for age 3-8, the grand total showing lower ratio in males. The sex difference in ratio differs greatly from one pair of dimensions to another. During growth (6-17) it is very small or nonexistent when weight or sitting height is one of the paired dimensions.

Among adults males show greater lag than females in face height on face breadth, and pelvic breadth on shoulder breadth.

Females show much greater lag in arm length on leg length and leg length on arm length than do males, and considerably greater lags (.09 and .10) of minimum frontal breadth on head breadth and on face breadth. Stature lags on arm length much more than in males (.16) and arm length on stature slightly more (.03). Stature-head circumference likewise show greater lag in females, as does span on stature. Stature, however, lags on span more in males than in females. Head height lags on head length more in females (.06) than in males. The greatest sex differential in ratio of lags is for stature-head circumference (-74), face breadth-minimum frontal breadth (27) and head length-head height (-22).

During growth (3-17) females generally show the greater lag in each dimension when stature is one of the paired dimensions, but in females 3-8 arm length is more accelerated on stature than in males.

For total age range 6-17 boys show less lag than girls in each pair of variables except sitting height-head length and head length-head width. Lag in girls is less in each of these latter two pairs of variables. The greatest sex differential is in lag of sitting height on weight, which is less in boys than in girls. Where acceleration occurs it is greater in boys than in girls, with the exception of acceleration of weight on head width, which is greater in girls than in boys.

DIFFERENTIAL LAGS IN DIMENSIONS AT AGE LEVELS DURING GROWTH

Inasmuch as proportions of body and head change during growth one would expect the phenomenon of lag to show differential values at various ages. Thus if cephalic index decreases during growth one would expect for a given age period during growth, such as 6 years of age, a greater lag in head breadth on length than of length on breadth. Since most series give age to nearest year, and the age of individuals grouped at a given year level has a range of 12 months these individuals are not of uniform age. Hence the so-called age level is really a grouping of individuals of specified limited age range. This qualification applies to all of the above series except the California children, all of whom were measured at the same postnatal age.

The following is an analysis of trends during growth. In Wallis' series, age 3-8 by year intervals, shoulder breadth of males lags on pelvis breadth less than the converse, except at age 3; in females, there is no consistent dif-

ference. Stature lags on other dimensions with which it is compared--shoulder breadth, pelvis breadth, trunk length, leg length, radius length--more than any of these on stature. In the London School boys, age 5-13, stature is accelerated on stem length, stem length and chest girth lag on stature. In Westminister boys, age 12-18, stature lags on stem length and chest girth. Stem length lags on chest girth more than chest girth on stem length. In Manchester boys, age 11-18, by year intervals, stature lags more on stem length for ages 11-14, and less for ages 15-18, than stem length on stature. Thus, as indicated by Wallis' series, both age level and sex affect differential in these two dimensions at certain age ranges.

In the Worcester series, age 6-17 by year intervals, male stature lags less on sitting height than the converse for ages 6, 8, 10, 13-14, sitting height showing less lag on stature than the converse for ages 7, 9, 11, 15-17. Stature lags less on head length and head breadth in each age group than the converse. In females stature lags less on sitting height than the converse for ages 6-12, 16, and more for ages 13-15, 17. In females as in males, stature lags less on head length and head breadth than either of these on stature. This is consonant with the trend during growth, when stature increases relatively faster than head length or head breadth. In males head length-head breadth shows less lag of head length for ages 6-7, 9, 13-16, and less lag of head breadth for ages 8, 10-12, 17. In females head length shows less lag on head breadth for ages 6-10, 13, and head breadth less lag on head length for ages 11-12, 14-16, the values being the same at age 17. For the total series, 6-17, lag of head length on head breadth is the same as lag of head breadth on head length for boys, and differs by only .01 in girls. For the total Worcester series stature lags more on sitting height than sitting height on stature, but less on head length and head breadth than either of these on stature. Sitting height, likewise, shows less lag on these head dimensions than either of them on sitting height.

In Oxford Undergraduates, age 18-22, by year intervals, stature lags on leg length, and thigh length, each of which is accelerated on stature. Stature lags less on head length and head breadth than either of these on stature, the only exception being equal lags of stature-head breadth at age 18. These differentials repeat those of the above series of younger age groups.

To test further the effect on lag of holding age constant we partialled out age in months in Worcester males for the respective year intervals 6-9 years of age, in which age is given to nearest month. The effect on lag is indicated by the coefficient of partial correlation. In this series, holding age constant by month rather than by year has little influence on lag. About the only exceptions are stature-sitting height, sitting height-weight, and sitting height-head length, and these only in the 9 year old group. In only one age group is there a change in lag of stature-head width when age in month rather than in year is held constant. In three age groups there is slightly increased lag in stature-head length when age in month is held constant. Lag in head length-head width increases at ages 6 and 7, decreases at age 8, and is the same as for zero order of correlation at age 9. The result of holding age in month constant within a year range during these years of growth appears, therefore, to vary with dimensions and also with age level, but in the main the lag remains the same.

Inasmuch as holding age in months constant, within year intervals, has very little influence on coefficient of correlation, there is little influence on respective lags of dimension; for ratio of coefficients of variation (Vx/Vy) remains the same.

Mean lag of these four age groups is decreased by partial correlation (age in month constant) for stature-sitting height, sitting height-weight, sitting height-head length. It is increased for stature-head length, sitting height-head width, head length-head width. Partial correlation gives greater accelera-

tion of weight on sitting height, and less acceleration of weight on head width.

The only comparison which can be made with California children is for length-stem length (California children) and stature-sitting height (Worcester males). In the former the lag of stem length on body length is .87; in Worcester males, age in mean month constant, it is .83; in the former the lag of body length on stem length is .78; in Worcester children lag of stature on sitting height is .88. It is not clear, therefore, that there are differentials in lags of these dimensions at these respective age periods, when age in month is held constant.

A comparison of lags during growth, at year intervals for mean age, with lags during adulthood shows the following: During growth head length lags less on head breadth than conversely for ages 6, 7, 9, 13 in males, and 6-10, 13 in females; the converse holds for ages, 8, 10-12, 17 in males, and 11, 12, 14-16 in females. In all large adult series head length lags more on head breadth than conversely.

Chest circumference - pelvic breadth show greater lags in U.S. soldiers than in California children up to 3 years of age (by 3 months intervals), but the ratio of soldiers is similar to that of children up to 12 months of age. The ratio then rises, from 47 to 73, to age 36 months. Lag in these children decreases in chest circumference from 1 month to 36 months and increases in pelvic diameter.

California children (1 month to 36 months) show less lag of pelvic breadth on shoulder breadth than conversely, the ratio ranging from 34 to 78. In New York children the ratio ranges from 90 to 208 in males, and from 76 to 123 in females, for 3-8 years of age, but with greater mean lag in pelvic breadth. In the Swedish series of males 21 years of age the ratio ranges from 64 to 71, pelvic breadth showing uniformly less lag than shoulder breadth. In New York children lag in pelvic breadth decreases with age, but females show no certain trend. California children likewise show no certain trend. In the last mentioned the greater lag of trunk length on pelvic breadth than conversely is duplicated in Swedish adults, but there are marked differences between the two series. In California children the ratio ranges from 22 to 63; in Swedish male adults, it ranges from 74 to 83. Moreover, the lag in pelvic breadth in Swedish adults is about 3 times that of the California children, from .33 to .36 as compared with .73 to 1.23 (acceleration) in the children. Mean lag in trunk length in Swedish adults is, conversely, greater than in the children: .26-.29 as compared with .19-.48 in the latter. Except for the 36 month group the ratios of lags in trunk length-shoulder breadth are below 100 (44-90), whereas in Swedish male adults, the ratios range from 106 to 123. In the adults the lag in shoulder breadth is about twice as great as in the children, and the lag in trunk length is more marked in the adults (.24-.31 as compared with .33-.59). New York children (2-8) show acceleration of arm length on stature for both sexes (.89-1.43 for males; .99-1.69 for females) and a lag of .51-.61 and .36-.60 of stature on arm length. In 1 series (Egyptians, males) adults show acceleration of arm length on stature, and in other series show little lag of arm length on stature (.84-1.03). In adult series stature lags on arm length .49-.71. The ratio of lags is, however, higher in adults than in New York children, 54-87, as compared with 36-69 in male children aged 2-8, and 24-54 for female children of this age range.

Chest circumference lags on stature less than conversely at each age interval and among adults. When, however, the age group 5-13, males, is considered as a unit, stature accelerates on chest circumference. For 11-18, and 12-18 years chest circumference is slightly accelerated on stature when these respective groups are treated as a series.

Head breadth lags more on stature than conversely at each age level, 6-17. The highest ratios in males occur at ages 13, 14, and 15, and in females

at ages 7 and 11. In males the lowest ratio occurs at age 17 (100) and in females at age 15 (125).

In adults the ratios range from 99 to 173, as compared with 100 to 300 in males and 125 to 280 in females for age periods 6-17 years. Oxford undergraduates, 18-22 years of age, show ratios, by year level, of 100 to 162. Thus the differential which characterizes growth is continued to age 22. Means of 83 ethnic groups show greater lag in head breadth than in stature, and greater lags in each than are found in other series.

In males, lags in head height-stature by year intervals 18-22 conform with lags in adults, except that lag of head height on stature is less for year intervals 18-22 than for adults.

The ratios of lags are comparable for age levels 18-22 and for adults: 72-125 for adults, 58-106 for age levels 18-22, a lower average in the latter group. Fifty-three ethnic group means show a ratio of 167, which is higher than that of any other series analyzed. Here the intergroup differential is more emphatic than the intragroup differential in lag.

At age levels 6-22 head length lags more on stature than conversely. The same differential is found in every series of adults, but the ratio is lower in adults than during growth, and decreases from 6 years to 16 years. Thus in males the ratio ranges from 205 at 6 years of age to 138 at 16 and 111 at 17, in Worcester children; and in females from 254 to 121 at 17. In Oxford undergraduates it ranges from 110 at 18 to 139 at 22, being 138 among Cambridge total undergraduates. The range for other series of adults is 113-179. A series of 83 ethnic group means gives a ratio of 186.

Leg length lags less on stature than the converse at each age level, 3-8, 18-22, and for adults. In fact, in males leg length is accelerated on stature at ages 4-6, 8, and 18-22, the maximum acceleration appearing at age 18. In females age 3-8, acceleration of leg length appears only at age 4. With the exception of this age group females show, for ages 3-8, greater lag of leg length on stature at each year level. (The numbers, however, are small--11-26). From 18-22 upper leg length shows comparable acceleration on stature (1.32-1.65) at each respective age level; this is a higher acceleration than that of leg length, or of lower leg length.

With two exceptions, both males and females show less lag of pelvic breadth on stature than conversely, for ages 3-8 (numbers 14-24). Adults show the same type of differential, but a more emphatic one. Thus in male adults the ratio ranges from 42 to 48, and in male children 3-8 it is 69-125. In males plus females age 3 months to 36 months the ratio is 22-61, that is, closer to the ratio of adults. At most of the age levels 3 months to 36 months there is acceleration of pelvic breadth on stature and much more lag of stature on pelvic breadth than during the period 3-8 years.

From 3 months to 36 months shoulder breadth lags less on stature than conversely, except at 36 months, the ratios ranging from 39 to 117. At age 3-8 years the same is true, except at age 3 in males.

Adult males show the same type of differentials; ratios range from 65 to 69 in Swedes at age 21, and 44 to 66 in Sioux.

In California children stature-stem length have equivalent lags at 3 months and 18 months. At all other age intervals in this group stature has the greater lag. Among New York children males show greater lag of stature at ages 3-5 and 7, and lesser lag of stature at ages 6 and 8. Females of this series show greater lags of stature at ages 4, 6-8, and smaller lags at 3 and 5. Worcester children likewise show reversals of ratio of lag at different age levels. Thus in males stature has less lag at ages 6, 8, 10, 13, 14, and greater lag at 7, 9, 11, 12, 15-17; in females there is greater lag of stature at ages 6, 13-15, 17, and less lag at ages 7-12, 16. For the total group (not by year levels) of London boys 5-13, the ratio is 53, and stem length is considerably

accelerated upon stature. For the Westminster boys age 12-18, as a group (not by year intervals), stem length is slightly accelerated upon stature, and the ratio is 80. In the large series of U. S. soldiers the ratio is 100; all other adult groups yield ratios considerably below 100, from 43 (in females) to 81 in males. In Swedish males, 21 years of age the total is 56 (54-61). Holding age constant appears to have considerable influence on the ratio of these lags during adulthood as well as during growth. The same observation applies to many other paired lags.

LAG IN LOWER ANIMALS

Inasmuch as lag is a characteristic of man, it seems likely that it may characterize other animals also. We have sampled some of the available data with the following results: In 500 individuals of species Arcella vulgaris, a shelled rhizopod, correlation of total (outer) diameter of the shell (Y) with (inner) diameter of the mouth opening (X) is .836. The r of $Y-\frac{Y}{X}$ is .71, of $Y-\frac{X}{Y}$ is -.62. (Pearl and Dunbar, Biometrika, 2:327, 330, 1902-1903).

Schuster gives measurements of dimensions of about 2,000 individuals of species Eupagurus prideauxi, divided into the two groups of deep water forms and shallow water forms. He measures the two dimensions, (1) from upper articulation of propodite with carpopodite of right chela to upper and outer articulation of propodite with dactylopodite, known as Measurement No. 1; and (2) length of right chela measured from its lower articulation with the carpopodite to furtherest point of the fixed blade of scissors. He believes his measurements accurate to 0.1 mm. From these two measurements he constructs the chela index, which is $\frac{\text{Measurement No. 1 - Measurement No. 2}}{\text{Measurement No. 2}}$. He also takes length of carapace along median line. Regression coefficient of this index on carapace length is -.27 and -.24, respectively; of carapace length on index, -.99 and -.81, respectively.

Lag is marked except in the female in one correlation. There is a distinct sex difference, though not always in the same direction, in the respective lags. In this series, higher positive correlation of dimensions in males accompanies higher negative correlation coefficients of dimension x with index y/x.

The data on young trout deal with periods when growth changes complicate the phenomenon of lag. The changes in correlation coefficient of dimension x with index y/x at different stages of growth may reflect a trend in changes in body proportions during growth.

In 1906 Pearl pointed out that in paramecium there is a "sensible correlation between the absolute size of the body and its shape as measured by length-breadth index." (Biometrika, 5:68, 70, 1906-1907). In series B breadth lags upon length more than length upon breadth. In the other series lag of length on breadth is greater than lag of breadth on length. In the turkey hen body length is accelerated on all dimensions except wing length and head width. All dimensions lag on body length. Data on the turkey hen show that neither the sign nor the value of the coefficient of correlation of absolute weights of organs gives any intimation of presence or absence of lag or of its value. Dimensions show much more consistent lag than do weights.

In male and female frogs weight of each organ is accelerated upon body weight except in the case of spleen; whereas body weight lags approximately 50 per cent upon weight of each organ. The only other instances of acceleration are of spleen on digestive tract, and of digestive tract on kidneys. Otherwise the least amount of lag is shown in liver on kidneys; digestive tract and

liver on each other; and liver and pancreas on each other. There are possibly sex differences in variability and correlation in frogs. The above results should be interpreted with that possibility in mind.

In male turtles, weight of liver and spleen is accelerated upon body weight. In every other instance there is less lag of weight of organ on body weight than of body weight on weight of compared organ--as also in the case of frogs. Comparison of lags in paired organs in turtles and frogs shows that though the lags differ in the two animals, the ratio of lags of paired organs is similar in the two animals in most cases. The number of turkey hens is so small (12) that little assurance can be given the specific findings. In Nebraska muskrats skull weight is accelerated on mandible weight, but lags on each recorded weight of long bones; the latter neither lag nor accelerate on skull weight.

SUMMARY

Anatomic lag, the lag of one dimension on another against which it is plotted, is exhibited by most dimensions in man and appears to be a characteristic of the animal kingdom, if the samples from various orders and genera given above are representative.

Lag has differential values for paired dimensions, as, for example, lag in head length-head breadth. Certain dimensions, as leg length-arm length, show little lag. The phenomenon applies not merely within a group but also between groups of similar racial composition, and therefore has intergroup application. It seems also to have interracial application, that is, to apply to means of racial groups. There appear to be sex differentials in lag.

During growth there is differential in lag in dimensions at most age levels.

The relative regression coefficient is perhaps the best measure of lag for comparative purposes and facilitates prediction of values of paired variables. The ratio of relative regression coefficients of paired variables provides a convenient expression of ratio of lag of the two and facilitates comparison of relative lag in paired variables of different series. Further analysis of relative regression coefficients and their ratios should provide a profitable comparative study of lag.

THE EFFECT OF IMPROVEMENT IN NUTRITION ON THE MENTAL CAPACITY OF YOUNG CHILDREN

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The influence of malnutrition in retarding mental development in infancy and early childhood is a subject worthy of serious consideration. Mental activity is a form of energy and the expression of mental capacity depends upon mental energy and mental effort. Mental capacity itself is dependent upon the development of the brain cells and these as well as other parts of the body must be nourished in order to attain their normal growth.

It has been shown by experiments on rats that normal rats are far superior in their learning ability to rats which have been deprived of Vitamin B during their nursing period (1, 2, 3, 4). Rachitic children compared with non-rachitic children, carefully paired, in the ages of 12 months, 18 months and 24 months show a lower developmental rating (5).

The difficulty in formulating a study of this type with human subjects lies in the fact that reliable mental records of malnourished or undernourished young children are rarely available in numbers sufficient for scientific analysis. If malnutrition is complicated by other factors which tend to retard mental growth, the case is valueless for a study of the effect of malnutrition. Loss of mental control through epilepsy, meningitis, encephalitis, paralysis, glandular dysfunction and the like is not calculable in terms of constants. These diseases often are accompanied by malnutrition, and institutional files abound in records showing these complications.

When records are available, there must be an interval of nutritional care, and a re-test to note changes in mental status. Another requirement is a control group of children of a normal nutritional status at the time of the first test with a record of normality in this respect in the interval and at the time of the re-test.

The method used in gauging nutritional changes is also of primary importance. The age-height-weight index has large variations within year levels and large overlappings in the different year levels. So called "slender types" often have medical diagnoses of good nutrition. Correlations based on this method are therefore apt to be lowered.

In a study made at the New York City Children's Hospital in 1923, based on the age-height-weight index (5), the correlation between change in nutritional index and change in I.Q. was $-.226 \pm .102$. This study was based on records of 40 boys ranging in age from 3 years and 8 months to 15 years 7 months. The intervals between measurements ranged from 2 months to 4 years, 2 months. Age and time interval did not appreciably affect the correlation. Inspection of the data, however, shows that 21 of the 40 boys were over 10 years of age and that only 7 were below 8 years of age. It may well be that the negative finding is due not only to the overlapping of nutritional criteria but to the age of the subjects. Mental control is conditioned not only by physical energy but by social and educational adjustment. Children committed to institutions are frequently maladjusted, coming as they do from intolerable situations in home and school environments. Negative self-feeling is engendered by association with brighter children, secret worries about domestic conditions or about their own disabilities are apt to preoccupy their minds. Bad mental habits have been formed in avoiding the struggle with tasks beyond their mental scope. Before the mind can function at its best each of these individual adjustments must be brought about. The degree of adjustment required and the success in adjustment are variables that cannot be held constant by statistical methods and

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they tend to vitiate statistical findings.

In the earlier years of life social consciousness is still comparatively undeveloped and conflicts have not been established in the same degree. Control factors are present, however, in many cases and must be taken into consideration in the selection of cases. Hyperactivity and wilfulness lower the results of many a mental test.

Investigations of nutrition in relation to scholarship records show positive findings in favor of better nourished children. These studies have no direct bearing on the present investigation as they do not take into consideration the developmental factors of early childhood. They do indicate that the mental energy and mental effort required for successful school work and for response to mental tests is heightened by good nutrition (6, 7, 8).

The procedure in the investigation here reported is to have two groups: Group I, malnourished at the time of the first test and well nourished at the time of the second test. Group II, well nourished at the time of the first test and still well nourished at the time of the second test, the diagnosis of good nutrition and malnutrition to be based on the physicians' statements in the record.[2] Doubtful cases or cases complicated by lack of mental control or enervating factors as described in the introduction are excluded. The two groups are to be equated as nearly as possible for chronological age, I.Q., and interval between tests. The chronological age limit at the upper ends is 7 years, 11 months. Ideally the lower limit should be at 6 months but as admission to the institution is rarely below age 2 years this condition is impracticable.

The tests used for both groups are Kuhlmann-Binet or Stanford-Binet. Cases in which these scales are not applicable are excluded in order to avoid the inaccuracies resulting from the differences in variability of performance scales.

Table 1 gives the range, average, and standard deviation of the two groups in age and I.Q. at the time of the first test, the interval, and I.Q. changes.

TABLE 1

GROUP I	41 CASES		MALNOURISHED
	Range	Average	σ
Age	2 yrs. 1 mo. to 7 yrs. 10 mos.	3 yrs. 10 mos.	1 yr. 5 mos.
I.Q.	22 to 82	45	16
Interval	8 mos. to 7 yrs. 0 mos.	3 yrs. 7 mos.	1 yr. 6 mos.
I.Q. change	-8 to +44	+10	12
GROUP II	41 CASES		WELL NOURISHED
	Range	Average	σ
Age	2 yrs. 7 mos. to 7 yrs. 7 mos.	4 yrs. 10 mos.	1 yr. 5 mos.
I.Q.	22 to 88	52	19
Interval	8 mos. to 8 yrs. 9 mos.	3 yrs. 4 mos.	2 yrs. 1 mo.
I.Q. change	-20 to +11	-0.3	6

Table 2 gives the intercorrelations of the two groups by the Pearson Product-Moments method.

The outstanding findings in this study are:

a) The average rise of 10 points in I.Q. for Group I who were definitely

[2] Case reports of the New York City Children's Hospital contain progress records each covering a period of three months. Physical, mental, and behavior changes are recorded from the observations of doctors, nurses, and teachers.

malnourished at the time of the first test, and well nourished at the time of the final test, in contrast to the average zero change in Group II who were well nourished throughout the period under consideration. The greater variability shown by a standard deviation of 12 points I.Q. in Group I against a standard deviation of 6 points I.Q. in Group II is probably due to the varying degrees of initial malnutrition and of improvement in nutrition. In the absence of reliable numerical measures of these factors a high variability in I.Q. rise is to be expected. The significance of the difference in I.Q. change, in favor of the malnourished group, $\left(\frac{D}{\sigma \text{ diff.}}\right)$ is 2.43, indicating that the chances are 99.2 in 100 that the difference is greater than zero.

TABLE 2

	Group I r	Group I P.E.$_r$	Group II r	Group II P.E.$_r$
Age at 1st test vs. I.Q. rise	-.56	± .08	-.003	± .106
I.Q. at 1st test vs. I.Q. rise	-.199	± .10	+.025	± .106
Interval vs. age	-.098	± .10	-.210	± .102
Interval vs. I.Q. rise	+.221	± .102	-.034	± .106
Age vs. I.Q.	+.23	± .102	-.007	± .106

b) The significant correlation between age at the time of the first test and I.Q. rise. The correlation of -.56 is a clear indication that the younger the malnourished child when nutritional care is begun, the greater is the chance of improvement in mental capacity. This correlation would be markedly raised if it were based on a normal age distribution instead of a limited section of the normal distribution.

The two groups are not perfectly equated. The average age of the well nourished group is 1 year and 3 months higher than that of the malnourished group. There were no 5 year olds in the malnourished group, and only 7 cases above 4 years in that group. The determination of the age level at which nutritional care becomes ineffective in raising the mental capacity, is therefore not within the scope of this study.

However, the sharp decline in the average I.Q. rise of the malnourished group after the age of 3 years (see Table 3) raises this question: To what degree is the harm done by malnutrition irreparable after the age of 4 years? The indication from our small number of cases above age 4 years is that only slight gains are to be expected.

TABLE 3

I.Q. CHANGE BY AGE

Age	Group I Malnourished		Group II Well nourished		
	No. of Cases	Average I.Q. Change	No. of Cases	Average I.Q. Change	Difference
2	11	+13	5	+2.4	+10.6
3	15	+14.4	7	-2.85	+17.25
4	8	+ 5.3	10	-1.8	+ 7.1
5	0	-----	8	+1.6	------
6	5	+ 1.6	9	-0.77	+ 2.37
7	2	+ .5	2	+1	- .5

The slightly positive correlation (-.22 ± 10) between length of interval and I.Q. rise in the malnourished group as compared with the zero correlation

in the well nourished group raises the question of the minimum interval required to bring about a rise in brightness. Our correlations are based on the I.Q. changes from the first to the final test. Within this period our subjects were re-tested at various times, so that we are enabled to show the gains at progressive intervals. (See Table 4).

TABLE 4

I.Q. CHANGE FROM 1ST TO 2ND TEST

Interval	No. of Cases	Average I.Q. Change	Range
6 mos. to 11 mos.	11	+ 5.6	- 4 to +20
12 mos. to 18 mos	12	+ 6.8	0 to +26
19 mos. to 25 mos.	7	+10.7	- 2 to +28
26 mos. to 32 mos.	6	+11.3	0 to +23
33 mos. to 5 yrs.	5	+ .6	-10 to + 9

The number of cases is too small for reliable generalization but the indication is that a period of 18 months to 2 years is required to bring about the average gain from nutritional care. The large range in each interval shows the variability in this respect.

In 9 cases there was a progressive rise in I.Q. following the rise from the first to the second test. In 7 cases there was no further rise after the second test although observations covered many years. Only 3 children, who were under observation for a number of years, showed slight drops in the second test to be followed by subsequent large gains. In these 3 cases the interval from first to second test was below 1 year. These figures have only a limited value as the periods of observation were determined by the time children remained in the institution, and the intervals between tests depended largely on demands made on the laboratory in other institutional case work.

Studies of 5, 6, and 7 year old children in malnourished and well nourished groups, of children below 2 years and 3 and 4 year groups selected outside of institutions and of higher mentality at the first test would serve to clarify this problem.

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THE RELATION OF ORDER OF BIRTH TO OTHER BIRTH FACTORS[1]

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INTRODUCTION

The question of the relative superiority of the different birth orders has been discussed and re-discussed for many years and the solution is not yet in sight. Since heredity and post-natal environment cannot theoretically and plausibly account for any superiorities or inferiorities present at birth so as to produce, on the average, a favorable or unfavorable effect on any particular birth rank, attention has naturally drawn to the pre-natal environment. The problem of the temporal relations in the birth sequence and the problem of whether the more healthful intra-uterine environment is a young one or one more advanced in years are, it seems, inextricably entangled. "The incidence of a trait in a given birth order or its average value on a quantitative scale may involve joint contributions from mother's age and from birth order acting as independent variables. These factors may vary in relative force, at different ages, at different birth positions, and in different social groups" (17). It is, therefore, necessary to separate the effects of one from the effects of the other.

It is the problem of this study to attempt to isolate statistically the separate effects of the ordinal position in the birth sequence and the age of the mother upon such factors as duration of pregnancy, number of antepartum complications, duration of labor, number of labor complications, type of delivery, and birth weight of infant.

The records of the Sloane Maternity Hospital in New York City were utilized.[3] Those cases were considered who had had two or more confinements resulting in live births at the hospital so that comparative data might be secured. In the study the ordinal number for birth order is based on the number of pregnancies, thus counting the number of children born living, stillborn, miscarriages, and abortions. The ordinal number for birth order is thus really the pregnancy order.[4]

Antepartum Complications. Some investigators have stated that the elderly primiparae are more prone to encounter a higher incidence of toxemias, albuminurias, and other complications than the other primiparae (24, 38). Others, however, have reported no relation between the incidence of antepartum complications and mother's age (30).

Some investigators have reported that certain kinds of complaints, such as nausea, vomiting, ankle edema, etc., were more common among primiparae and secundiparae than in the higher multiparae who appeared to complain more of such complications as severe headaches, varicose veins, dyspnea, etc. There was no relation found between parity and number of complaints (19). However, others have studied the question of the relation of birth order to antepartum complications with negative results (18, 35). One study of mothers' reports as to their health during pregnancy and medical records reported no evidence of a relationship between pregnancy order and the health of the pregnant mother (18). However, it has been found that mothers tend to forget the illnesses and disturbances suffered during pregnancy, the injuries received at the birth

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[3]The author is indebted to Dr. Benjamin Watson for his kind permission to have access to the material furnishing the data of this study.

[4]Although pre-natal casualties were taken into account in determining the pregnancy order, only the data of live births were utilized in comparisons of pregnancy duration, antepartum and labor complications, labor duration, and birth weight.

of the child, and the use of instruments at that time (31). Some scientists have felt that although pre-natal conditions might be less favorable to primiparous mothers with a tendency to uncommonly severe toxemias and other disturbances of pregnancy, it is not well-established that this is an important differential factor in handicapping the first-born except at the extremes of the child-bearing period (17).

Duration of Pregnancy. It has been reported that the duration of pregnancy has no relation to mother's age but that it correlates with birth weight rather highly (5, 16, 22). The inferior weight of children of primiparae has been explained in terms of their shorter average duration of pregnancy as compared with those of multiparae (5). However, other investigators have not been able to find any significant differences either in mean length or in standard deviation between first and later pregnancies, (16). No correlation has been found between length of gestation and the duration of first and second stages of labor (1).

Labor Complications. It has been shown that as the age of the primipara increases labor becomes more difficult and dangerous (24, 38), the chief possibilities of complications being rigid soft parts, inefficient uterine contractions, poor engagement of the head or abnormal positions, and minor grades of pelvic contraction (23). In fact, it has been reported that in the elderly primiparae contracted pelves occur two to four times as frequently as in young ones (6). Studies of two groups of primiparae, aged 30-35 years and 36-45 years, showed in the latter group a much greater incidence of premature rupture of the membranes, manual separation of the placenta, and premature labor in addition to some increase in the incidence of breech presentations and eclampsia (33).

Some studies of the relation of mother's age to the incidence of labor complications have reported negative results. It has been found that elderly primiparae do not show any greater percentage of perineal lacerations or labor complications in general than do younger ones (14, 41) although increasing age from 31 through 45 years of age has been reported to bring a greater incidence of weak uterine contractions and uterine inertia (14).

The effect of parity on the incidence of labor complications does not seem to be clear-cut. On the one hand, we find that multiparae have been reported to have less perineal tears, more vaginal outlet relaxations, less strong levator muscles, more cervical tears, and more sub-involutions of the uterus than primiparae (28) while, on the other hand, increasing parity has been reported to bring with it certain changes that gradually increase the risk of childbirth--namely, loss of muscle tone, a tendency to hemorrhage, and calcium depletion (set up by excessive parity) which render the muscles painful and flabby and enhance the effects due to loss of muscle tone (35). It has been reported that repetition of parturition and lactation, especially when combined with poverty, overwork, and underfeeding, might set up a decalcification of the pelvic bones and cause a shrinkage in the bony birth canal that might react upon the mechanism of labor (35).

Duration of Labor. Some investigators have been able to demonstrate a relationship between mother's age and length of labor. Some have shown that elderly primiparae have shorter labors than young ones (2) while others have shown just the reverse (14, 25, 38, 41). It has been stated by one investigator that this prolonged labor in the elderly primipara is due primarily to the greater incidence of abnormal presentations and inertia uteri whereas the greater elasticity of the soft tissues in the young primipara accounts for her shorter labor. The same investigator felt that irregularities in menstruation and particularly the late establishment of the function seemed in some manner to influence the type and duration of the labor which was, however, uninfluenced by the time of marriage or conception (25).

Other investigators have failed to find any relation between mother's age

and duration of labor. Studies of the labors of elderly and young primiparae have failed, in some instances, to show differences in duration (1, 32, 35, 37). In one study, age seemed inversely proportional to labor duration when all cases were considered (that is, no account being taken of parity) but when primiparous and multiparous labors were analyzed separately age lost its significance and apparently had no effect on duration of labor. Neither the weight of the mother nor the weight of the infant seemed to correlate significantly with the duration of labor. Thus the results apparently controverted the beliefs of the long labor of the fat woman, of the elderly primipara, or of the large baby (1).

The effect of birth order on duration of labor has been studied by some investigators. The majority have found that there is a negative relation between parity and duration of labor, that is the primiparae have been found to have longer labors than the multiparae which has been explained by the former's greater resistance of the soft parts (1, 27, 42). However, no significant change in duration was to be noted with increasing multiparity since the decrease in duration was almost entirely confined to the space between primiparae and secundiparae. Although there was no further decrease in the first stage of labor, with succeeding pregnancies there was some shortening of the second stage in multiparae because of decreased resistance of the cervix, vaginal walls, and pelvic floor (1).

Type of Delivery. Elderly primiparae have been found to show a greater incidence of operative delivery, either by forceps or Caesarian section, than younger ones (2, 23, 33, 38) showing progressive increase from 20 through 45 years of age (14, 21, 26) as well as a greater percentage of breech persentations (14).

The incidence of abnormal confinements seems to drop with increasing parity (18). It has been reported that the percentage of operative and instrumental deliveries in primiparae is considerably higher than in multiparae (18, 27, 29). However, following a decrease to an optimal low for the para 4 and 5 groups, there is a steady and rather rapid rise (27). While instrumental delivery occurs most frequently among the first-born it has been found that the use of drugs is more common in the higher pregnancy orders (18).

Birth Weight. Investigators who have found a relationship between mother's age and birth weight have reported conflicting results. On the one hand, some have found a small negative correlation between birth weight and mother's age (18) considering all birth orders; others have found a small negative correlation for the first rank of birth only (22) or have reported that the average birth weight of infants of elderly primiparae was less than that of young primiparae (33). On the other hand, a group of investigators have reported that the older mothers tend to have heavier infants with the highest average birth weight found in infants of mothers aged 25-35 years (3, 4, 7). While it has been found that there exists a slight positive correlation between the age of the mother and the infant's birth weight (7, 11, 41) it cannot be concluded that there is a direct causal relationship between mother's age and the characteristics of the child since there is a positive correlation between birth order and the measurements of the infant and since birth order is closely correlated with mother's age (11, 12).

Some investigators have reported variously that mother's age bears no relation to birth weight (22). Studies of elderly and young primiparae have failed to reveal differences in the birth weights of their infants (25, 32). "The age of the mother bears no decisive influence of its own on the dimensions of the foetus; the increase which is found in these dimensions is simply due to the fact that the greater the age of the mother the greater is the number of previous deliveries, and it follows that if the women married as soon as they were capable of bearing children we should expect, with a rise in the fertility, an increase in these dimensions in the foetuses" (8).

Relatively few studies have shown that the later-born tend to be inferior in weight (34). The majority of studies give evidence that the infants of multiparae tend to be heavier than those of primiparae (4, 9, 39). It has been found that the birth weight increases with order of birth (5, 8, 10, 13, 18, 27, 36, 40) until near the close of the child-bearing period (15). These birth weight differences, of course, are believed to be somatic phenomena which there are no reasons to believe produce any inherited effect (15) or biological inferiority (18). It has been stated by some that the birth weight of a child is an example of a trait in which mother's age and birth order have a joint but unequal influence (17). Other factors have been mentioned as influencing the birth weight. Some have spoken, in this connection, of the mother's weight (5), maternal immaturity and the difficulties incident upon bearing the first child (15), slightly shorter duration of pregnancy of the earlier-born (the first pregnancy might be expected to include not only more children diagnosed as premature, but also more children who are born between the zone of prematurity and normal term) (18), economic status and race of mother (39), sex of infant (39), and interval between successive pregnancies (7).

RESULTS

While the literature cited above deals chiefly with the parity of the mother (the number of foetuses brought to term as live births) the results of this study are mainly concerned with the mother's gravidity (the number of foetuses conceived). Since the parity (order of birth) and the gravidity (order of pregnancy) are closely related the results of this study are comparable to those cited.

The data of the pregnancy records of 285 ward patients were incorporated in this research. In order to take care of the possible divergence in the hereditary factors of different families and to avoid errors due to social selection, the sibling infants of the same mother were compared. All birth orders beyond the fourth were omitted from the study because the number of cases beyond this birth order was too small to encourage statistical reliability. From each record there was ascertained for each pregnancy the parity,[5] gravidity, mother's age, date of last menstruation,[6] date of labor, birth weight of infant, antepartum complications,[7] and labor complications.[7] Both white and colored women were used. No control was made of the following factors in the present research: nationality, race, weight, previous health, temperament, food intake, and activity.

Table 1 presents the duration of pregnancy (in days) comparisons of sibs of the different birth orders. In general, there is no great difference in duration of pregnancy favoring either the younger or elder sibs. The differences are not statistically reliable.

Table 2 shows the duration of labor (in minutes) comparisons of sibs of the different birth orders. In every comparison the younger sibs have the

[5]In subsequent studies it is planned to investigate the effects of order of birth, mother's age, and natal interval upon such factors as mother's weight at birth, gain in weight and blood pressure variations during pregnancy, and sex of infant.

[6]Hotelling and Hotelling (16) state that there is no perceptible gain in accuracy of estimation of duration of pregnancy by reckoning even from a single coitus of known date, unless of course, the menstruation date is unknown. They believe that it is just as accurate to use the beginning or the last day of the last menstruation.

[7]Antepartum and labor complications were listed by the hospital authorities on a printed sheet. The obstetrician would encircle in each case the particular complication involved. Although every possible complication commonly encountered was listed, there was room left to insert any less common ones that occurred. It is recognized, of course, that although one antepartum complication has been assumed equal in its effect and significance to another antepartum complication and one labor complication also equal to another in this quantitative study, such is probably not the case.

TABLE 1

MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION, AND SIGNIFICANCES OF MEAN DIFFERENCES IN DURATION OF PREGNANCY (IN DAYS) OF SIBS N = 375

Birth Order Rel.	N	Older			Younger			Diff.	Crit. Ratio	Prob.
		Mean	S.D.	C.V.	Mean	S.D.	C.V.			
1-2	172	278.6	14.2	5.1	277.5	18.1	6.5	-1.1	.65	74
1-3	45	277.6	12.7	4.6	278.8	15.1	5.4	1.2	.41	65
1-4	11	265.4	16.2	6.1	277.7	22.0	7.9	12.3	1.73	96
2-3	90	279.4	16.2	5.8	280.3	17.7	6.3	0.9	.38	65
2-4	25	282.8	24.5	8.7	282.9	15.9	5.6	0.1	.02	51
3-4	32	275.8	22.0	8.0	277.5	22.1	8.0	1.7	.46	67

TABLE 2

MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION, AND SIGNIFICANCES OF MEAN DIFFERENCES IN DURATION OF LABOR (IN MINUTES)OF SIBS N = 375

Birth Order Rel.	N.	Older			Younger			Diff.	Crit. Ratio	Prob.
		Mean	S.D.	C.V..	Mean	S.D.	C.V.			
1-2	172	1184.8	670.8	56.6	596.1	413.9	69.4	-588.7	10.65	100
1-3	45	1120.2	581.6	51.9	611.6	369.7	60.4	-508.6	5.24	100
1-4	11	1112.9	904.5	81.3	582.2	505.6	86.8	-530.7	2.08	98
2-3	90	706.9	517.4	73.2	548.7	423.0	77.1	-158.2	2.49	99
2-4	25	625.4	415.9	66.5	491.8	385.4	78.4	-133.6	1.38	92
3-4	32	619.9	389.4	62.8	556.2	394.1	70.9	- 63.7	.79	79

shorter duration of labor and, with two exceptions, the reliabilities are all significant. In every comparison larger coefficients of variation indicate that the later labor durations are more variable. The greatest differences in duration of labor are found when the duration of labor of the first-born is compared with that of later births.

Table 3 shows the birth weight (in grams) comparisons of sibs of the different birth orders. With one exception, the younger sibs show greater birth weight in every comparison. The differences are statistically reliable in three of the six comparisons. In all, save one comparison, the later births have smaller coefficients of variation, indicating less variability in birth weight than shown by their elder sibs. In order to observe the relative effects of increasing intervals between birth orders upon birth weight, all of the 294 pairs of sibs separated by one birth order (such as 1-2, 2-3, 3-4) were compared as were the 70 pairs of sibs separated by two birth orders (such as 1-3, 2-4) and the 11 pairs of sibs separated by three birth orders (such as 1-4). The birth weight differences of sibs separated by one birth order was 92.3 gms., by two birth orders 246.8 gms., and by three birth orders 453.0 gms. This appears to be evidence of a geometric relationship.

TABLE 3

MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION, AND SIGNIFICANCES OF MEAN DIFFERENCES IN BIRTH WEIGHT OF INFANT (IN GRAMS) OF SIBS N = 375

Birth Order Rel.	N	Older			Younger			Diff.	Crit. Ratio	Prob.
		Mean	S.D.	C.V.	Mean	S.D.	C.V.			
1-2	172	3222.0	458.7	14.2	3370.9	463.4	13.7	148.9	4.08	100
1-3	45	3170.2	493.8	15.6	3475.0	496.1	14.3	304.8	4.68	100
1-4	11	2862.5	561.6	19.6	3315.5	461.0	13.5	453.0	2.68	99
2-3	90	3366.2	525.3	15.6	3418.7	515.3	15.1	52.5	1.07	85
2-4	25	3350.1	619.3	18.5	3492.6	544.2	15.6	142.5	1.51	93
3-4	32	3493.1	400.9	11.5	3393.2	624.9	18.4	-99.9	.94	83

When all of the sibling pairs in the first four pregnancy orders are considered, the birth weight data available for 375 pairs of earlier-versus later-born siblings indicates that in 38.4 per cent[8] of the pairs the earlier-born are heavier and in 60.8 per cent the later-born are heavier while in 0.8 per cent the birth weights are the same.

Table 4 presents the averages, standard deviations, and coefficients of variation of all the 614 births for birth order, mother's age, duration of pregnancy, duration of labor, and birth weight. The greatest variability occurs in duration of labor wheras the least occurs in duration of pregnancy.

TABLE 4

AVERAGES, STANDARD DEVIATIONS, AND COEFFICIENTS OF VARIATION OF ORDER OF BIRTH, MOTHER'S AGE AT BIRTH, (IN MOS.) DURATION OF PREGNANCY, DURATION OF LABOR, AND BIRTH WEIGHT
N = 614

	Order of Birth	Mother's Age	Duration Pregnancy	Duration of Labor	Birth Weight
Average	2.04	314.40	278.25	789.68	3332.02
Standard Dev.	.91	59.15	17.54	584.17	501.94
Coeff. of Var.	44.6	18.8	6.3	74.0	15.1

Correlation coefficients[9] were computed between order of birth, mother's age, duration of pregnancy, duration of labor, and birth weight. Partial correlations were computed where the variables order of birth, mother's age, duration of pregnancy, duration of labor, and birth weight were held constant. Tables 5 and 6 present the correlation coefficients obtained. Because of the multiplicity of factors involved the results of the partial correlations will be stressed. Even though the great majority of the correlation coefficients obtained are significant the low degrees of relationship found make it evident that they indicate slight tendencies and should be accepted with caution until further corroboration is reported by other investigators.

TABLE 5

INTERCORRELATIONS BETWEEN ORDER OF BIRTH, MOTHER'S AGE AT BIRTH, DURATION OF PREGNANCY, DURATION OF LABOR, AND BIRTH WEIGHT
N = 614

	Mother's Age	Duration of Pregnancy	Duration of Labor	Birth Weight
Order of Birth	+.35	-.02	-.36	+.15
Mother's age		+.25	-.25	+.20
Duration Preg.			-.15	+.18
Duration Labor				+.19

When the effects of mother's age are held constant there is a low negative correlation (-.12) between order of birth and duration of pregnancy and hence tends to conceal the true negative relation between order of birth and duration of pregnancy. It would appear then that the uncontrolled factor of mother's age complicated and distorted the results of Table 1. There is an appreciable negative correlation (-.35) between order of birth and duration of labor which is relatively unaffected by the other variables. This confirms the results of Table 2. There is a low positive relation (+.11) between order of birth and birth weight which is also relatively unaffected by the other variables.

[8]This figure agrees well with that of Jones and Hsiao (18) who found that in 39 per cent of 639 pairs of earlier-versus later-born sibs the earlier-born were heavier.

[9]All coefficients of .12 or above are significant since they are four or more times their P.E. when N= 614.

TABLE 6

INTERCORRELATIONS BETWEEN ORDER OF BIRTH, MOTHER'S AGE, DURATION OF PREGNANCY, DURATION OF LABOR, AND BIRTH WEIGHT WITH ONE OR MORE OF THESE VARIABLES PARTIALLED OUT N = 614

Legend: 1 = birth order 3 = duration pregnancy
2 = mother's age 4 = duration of labor
5 = birth weight

r = +.35 12	r = -.02 13	r = -.36 14	r = +.15 15	r = +.25 23	r = -.25 24	r = +.20 25	r = -.15 34	r = +.18 35	r = +.19 45
r = +.37 12.3	r = -.12 13.2	r = -.30 14.2	r = +.09 15.2	r = +.28 23.1	r = -.14 24.1	r = +.16 25.1	r = -.17 34.1	r = +.18 35.1	r = +.26 45.1
r = +.29 12.4	r = -.08 13.4	r = -.36 14.3	r = +.15 15.3	r = +.22 23.4	r = -.22 24.3	r = +.17 25.3	r = -.10 34.2	r = +.14 35.2	r = +.25 45.2
r = +.33 12.5	r = -.05 13.5	r = -.40 14.5	r = +.24 15.4	r = +.22 23.5	r = -.30 24.5	r = +.26 25.4	r = -.19 34.5	r = +.22 35.4	r = +.23 45.3
r = +.32 12.34	r = -.16 13.24	r = -.31 14.23	r = +.11 15.23	r = +.27 23.14	r = -.10 24.13	r = +.12 25.13	r = -.14 34.12	r = +.11 35.12	r = +.29 45.12
r = +.36 12.35	r = -.13 13.25	r = -.33 14.25	r = +.18 15.24	r = +.26 23.15	r = -.19 24.15	r = +.21 25.14	r = -.23 34.15	r = +.23 35.14	r = +.30 45.13
r = +.25 12.45	r = -.14 13.45	r = -.41 14.35	r = +.25 15.34	r = +.17 23.45	r = -.27 24.35	r = +.23 25.34	r = -.15 34.25	r = +.18 35.24	r = +.26 45.23
r = +.28 12.345	r = -.17 13.245	r = -.35 14.235	r = +.20 15.234	r = +.23 23.145	r = -.15 24.135	r = +.16 25.134	r = -.18 34.125	r = +.16 35.124	r = +.31 45.123

This confirms the results of Table 3.

There is a low positive correlation (+.26) between mother's age and duration of pregnancy which is not much affected by the other variables. When the effects of order of birth and birth weight are partialled out the original correlation of -.25 between mother's age and duration of labor drops to -.15 indicating that the original correlation was high because of the high negative correlation between order of birth and duration of labor. It would appear then that the major cause of a decreasing duration of labor with an increasing birth order is primarily due to the effects of the repeated births and not necessarily to mother's age. There is a low positive correlation (+.12) between mother's age and birth weight which is relatively unaffected by the other variables. It will be recalled that the correlation between order of birth and birth weight is of about the same magnitude (+.11), indicating that the relation between birth weight and either order of birth or mother's age is no greater in one case than in the other.[10] In passing it is interesting to note the appreciable positive correlation (+.31) between duration of labor and birth weight, indicating the physical difficulties of the birth of larger infants.

Table 7 shows how the percentage of spontaneous deliveries increase from the first to the fourth birth order and how the percentage of instrumental deliveries decrease with increasing parity. The first birth order shows the great-

[10]The value of the regression equation is twofold: (1) In its usual form, it gives the weights to be assigned to each of several independent variables in order that X_1 (the dependent variable) may be predicted or forecasted with minimum error. (2) In its "special" form the regression equation may be used to analyze within certain limits --- a given capacity or ability. In the "special" form the sigmas of all of the different tests or variables are taken as equal. This procedure eliminates differences in the size of the test or measuring units as well as differences in "spread" or variability and enables us to determine (from the correlation alone) the relative weight with which each independent factor "enters into" or contributes to the dependent variable (the criterion) independently of the other factors. In this way an analysis can be made of the importance of several different factors in some final result. It is very important to remember, however, that in its special form, the regression equation cannot be used for forecasting. (Cf. H. E. Garrett, Statistics in psychology and education. Longmans, Green Co., 1931, page 254). In order to determine from the correlations above the relative weights with which order of birth, mother's age, and duration of pregnancy "enter into" or contribute independently to the birth weight, a regression equation in its "special form" was constructed for this analytical purpose. It was found that all three "enter" about equally and are thus equally important in determining the birth weight. The regression equation constructed was:

$$X_1 = .12\,X_2 + .13\,X_3 + .11\,X_4 + K$$

where X_1 is birth weight, X_2 is birth order, X_3 is mother's age, X_4 is duration of pregnancy and K is a numerical constant.

TABLE 7

PERCENTAGES OF EACH TYPE OF DELIVERY BY ORDER OF BIRTH
N = 614

Order of Birth	N	Spontaneous per cent	Instrumental per cent
1	195	66.2	33.8
2	246	89.0	11.0
3	127	92.1	7.9
4	46	95.7	4.3
Average		82.9	17.1

est incidence of instrumental delivery. The greatest increase in spontaneous deliveries (and hence the greatest decrease in instrumental deliveries) is found between the first and second birth orders.

Table 8 shows essentially the same results as Table 7 except that the sib pairs of the same families are compared thus holding constant the hereditary and social selection factors. In every comparison, with one exception, the younger sibs (later-born) have the greater percentage of spontaneous deliveries and the smaller percentage of instrumental deliveries. However, in only 2 of the 6 comparisons are the differences reliable.

TABLE 8

PERCENTAGES OF EACH TYPE OF DELIVERY BY COMPARISON OF SIBS
N = 375

Birth Order Relation	N	Spontaneous per cent					Instrumental per cent				
		Older	Younger	Diff.	Crit. Ratio	Prob.	Older	Younger	Diff.	Crit. Ratio	Prob.
1-2	172	64.0	90.1	26.1	6.07	100	36.0	9.9	26.1	6.07	100
1-3	45	77.8	93.3	15.5	2.15	99	22.2	6.7	15.5	2.15	99
1-4	11	100.0	100.0	0.0	.00	0	0.0	0.0	0.0	.00	0
2-3	90	88.9	95.6	6.7	1.72	96	11.1	4.4	6.7	1.72	96
2-4	25	92.0	96.0	4.0	.60	73	8.0	4.0	4.0	.60	73
3-4	32	87.5	93.2	5.7	.78	78	12.5	6.8	5.7	.78	78

Table 9 presents the percentages of abnormal births for the different pregnancy orders. The percentage of abnormal births decreases from the first to the fourth pregnancy order. The greatest percentage of miscarriages, stillbirths, and abortions occurs in the first pregnancy order.

TABLE 9

PERCENTAGES OF ABNORMAL BIRTHS CLASSIFIED ACCORDING TO PREMATURES, MISCARRIAGES, ABORTIONS, AND STILLBIRTHS IN THE DIFFERENT PREGNANCIES N = 285

Pregnancy Order	Kind of Birth		Prenatal Casualties			Total Abnormal Births
	Normal	Premature	Miscarriages	Abortions	Stillbirths	
1	81.4	1.8	7.1	4.4	5.3	18.6
2	92.7	0.8	2.7	3.8	0.0	7.3
3	93.4	0.0	3.7	2.2	0.7	6.6
4	97.8	0.0	0.0	0.0	2.2	2.2

Table 10 shows the incidence of antepartum complications and of labor complications from the first pregnancy order to the fourth. The percentage of antepartum complications increases while the percentage of labor complications

TABLE 10

INCIDENCE OF ANTEPARTUM AND LABOR COMPLICATIONS BY PREGNANCY ORDER (IN PER CENT) N = 614

Pregnancy Order	N	Antepartum Complications	Labor Complications
1	195	28.7	56.4
2	246	31.7	51.6
3	127	37.8	52.0
4	46	39.1	37.0

decreases from the first to the fourth pregnancy. This might indicate that, with increasing pregnancy order, the individual is becoming more susceptible to the ills of advancing age since she is aging physiologically although, at the same time, the process of reproduction, from a mechanical viewpoint, is becoming more perfected and adapted to its functions. It was found, as stated below, that there was a biserial correlation of +.10 between mother's age and the incidence of antepartum complications. However, the biserial correlation of +.10 between mother's age and the incidence of labor complications tends to show that the decreasing incidence of labor complications in the higher birth orders is a function of factors connected with the number of previous pregnancies rather than with the age of the mother.

Table 11 presents essentially the same results as Table 10 except that the sib pairs of the same families are compared, thus holding constant the factors of heredity and social selection. In every comparison the later-born show the greater incidence of antepartum complications. In only one of the six comparisons is the difference statistically reliable. In order to see the relative effects of increasing intervals between pregnancy orders on incidence of antepartum complications all of the 294 pairs of sibs separated by one pregnancy order were compared as were the 70 pairs of sibs separated by two pregnancy orders and the 11 pairs of sibs separated by three pregnancy orders. The differences in incidence of antepartum complications represented by one pregnancy order difference was 7.8 per cent, by two pregnancy orders 8.6 per cent, and by three pregnancy orders 9.1 per cent. This is some evidence of a linear relationship. From Table 11 it is seen that, with one exception, the later-born show less incidence of labor complications in every comparison. The differences, however, are not reliable in any comparison.

TABLE 11

PERCENTAGE OF INCIDENCE OF ANTEPARTUM AND LABOR COMPLICATIONS BY COMPARISON OF SIBS N = 375

Pregnancy Order Relation	N	Antepartum Complications					Labor Complications				
		Older	Younger	Diff.	Crit. Ratio	Prob.	Older	Younger	Diff.	Crit. Ratio	Prob.
1-2	172	29.1	32.6	3.5	.71	76	57.0	55.8	1.2	.23	59
1-3	45	26.7	31.1	4.4	.46	67	55.6	51.1	4.5	.43	66
1-4	11	18.2	27.3	9.1	.53	70	54.6	36.4	18.2	.87	81
2-3	90	26.7	41.1	14.4	2.06	98	46.7	53.3	-6.6	.89	82
2-4	25	24.0	40.0	16.0	1.23	89	40.0	36.0	4.0	.29	62
3-4	32	21.9	34.4	12.5	1.12	86	43.8	40.6	3.2	.26	60

Table 12 shows the coefficients of contingency computed between the incidence of antepartum complications, labor complications, and instrumental delivery. There appears some small tendency for antepartum complications to go along

with labor complications (+.09) and for labor complications to go along with instrumental delivery (+.09). These coefficients are not reliable.

TABLE 12

COEFFICIENTS OF CONTINGENCY BETWEEN INCIDENCE OF ANTEPARTUM COMPLICATIONS, LABOR COMPLICATIONS, AND INSTRUMENTAL DELIVERY
N = 614

	Incidence of Labor Complications	Incidence of Instrumental Deliveries
Incidence of Antepartum Complications	+.09	.00
Incidence of Labor Complications		+.09

Table 13 presents the biserial correlation coefficients between mother's age, duration of pregnancy, duration of labor, birth weight, incidence of antepartum complications, labor complications, and instrumental delivery. The most significant and statistically reliable correlation is between incidence of instrumental delivery and the duration of labor (+.37). There is a slight tendency (+.17) for duration of labor to be associated with labor complications.

TABLE 13

BISERIAL CORRELATIONS BETWEEN MOTHER'S AGE, DURATION OF PREGNANCY, DURATION OF LABOR, BIRTH WEIGHT, INCIDENCE OF ANTEPARTUM COMPLICATIONS, LABOR COMPLICATIONS, AND INSTRUMENTAL DELIVERY
N = 614 COEFFICIENTS OF .12 OR ABOVE ARE SIGNIFICANT

	Incidence of Antepartum Complications	Incidence of Labor Complications	Incidence of Instrumental Deliveries
Mother's Age	+.10	+.10	-.07
Duration of Pregnancy	-.02	+.12	+.14
Duration of Labor	-.02	+.17	+.37
Birth Weight	-.08	+.08	+.02

DISCUSSION

Both partial correlations and direct comparisons of sibs of the same family point to shorter labors and greater birth weights of the later-born. Not only are the later-born heavier than the earlier-born but the third born are heavier than the second born and the second born are heavier than the first born. It is not merely a matter of somatically handicapping only the first born but rather a handicapping, in general, of an earlier-born child, be he first, second, third born etc., when compared with a later-born child. There appears to be evidence of geometric relation between differences in birth weight and intervals of birth orders, that is, the birth weight differences of three birth order intervals are about twice as large as those of two birth order intervals and the birth weight differences of two birth order intervals are about twice as large as those of one birth order interval.

Direct comparison of siblings indicates that the later-born have longer pregnancies (not statistically reliable). However, partial correlations which hold

constant the mother's age give evidence that order of birth per se correlates negatively with duration of pregnancy. It appears then that the positive relationship between mother's age and duration of pregnancy tends to conceal the negative relationship between order of birth and duration of pregnancy when direct comparison of sibs are made.[11] This would tend to show that the two factors, mother's age and order of birth, oppose each other in influencing the duration of pregnancy. However, both mother's age and order of birth correlate negatively with duration of labor.

Order of birth and mother's age are of about equal importance in determining the birth weight of the infant. It would appear then that the greater birth weight of the later-born would not be due alone to any biological changes associated with the age of the mother. With increasing birth order comes a decreased variability in birth weight. "Possibly a certain reproductive 'maturing' may take place, a process that does not result from age but from repeated functioning of the reproductive system. The observed decrease in variability of the later-born then may result from a more uniform reproduction as a result of this process" (20).[12] Functioning and aging may both act together to bring about this "maturing".

The later-born tend to have a greater percentage of spontaneous deliveries, a smaller percentage of instrumental deliveries, a greater percentage of normal births,[13] a smaller percentage of abnormal births, a greater incidence of antepartum complications (a fact which may be due to the increasing age of the mother since a biserial correlation coefficient of +.10 was found between mother's age and incidence of antepartum complications), and a lesser incidence of labor complications (this ties up with the evidence of a decreased duration of labor in the later-born found by direct comparison of sibs and by partial correlations and with the evidence of a positive relation (biserial correlation of +.17) between duration of labor and incidence of labor complications). As mentioned above, the biserial correlation of +.10 between incidence of labor complications and mother's age indicates that the decrease in labor complications in the higher birth orders is a function of factors connected with order of birth and not with mother's age. There is evidence of a relation between birth weight and duration of labor (+.31) and between duration of labor and incidence of instrumental deliveries (+.37) revealing thereby that the birth of larger infants usually takes longer and sometimes necessitates the use of instruments.

SUMMARY AND CONCLUSIONS

1. The records of 285 multiparae were examined at the Sloane Maternity Hospital in New York City for the relationship of order of birth to incidence of antepartum complications, duration of pregnancy, incidence of labor complications, duration of labor, and birth weight.

2. There is a tendency for the later-born to have a greater birth weight. There appears to be some evidence of a geometric relation between differences in birth weight and intervals of birth orders, that is, as the intervals increase arithmetically the birth weight differences increase approximately geometrically.

[11]This would tend to explain why the studies cited above have failed to find any constant relationship between order of birth and duration of pregnancy or between mother's age and duration of pregnancy since factors other than those under consideration might be uncontrolled and thus distort the results.

[12]Locke and Goldstein (20) observed this superiority of the later-born as well as their decreased variability in a study of the intelligence of 1345 pairs of earlier-versus later-born sibs.

[13]Jones and Hsiao (18) compared the incidence of normal births in the sibling pairs of the first five pregnancy orders and found that out of ten possible comparisons eight showed that the later-born had a higher incidence of normal births although the differences were too small to be statistically reliable.

The later-born are less variable than the earlier-born in birth weight. Order of birth and mother's age seem to "enter" equally in determining the birth weight.

3. There is a slight negative relation between order of birth and duration of pregnancy when the disturbing factor of age of mother is held constant. However, mother's age and duration of pregnancy show a positive correlation (+.28) when order of birth is held constant thus indicating that the foetuses of older mothers tend to have longer pregnancies. It is possible that there is some physiological effect in the aging of the mother that makes for longer pregnancies.

4. There is a tendency for the later-born to have shorter durations of labor as shown by a correlation of -.35 between order of birth and duration of labor when mother's age, birth weight, and duration of pregnancy are held constant. There is a slight negative correlation (-.15) between mother's age and duration of labor when the other variables are partialled out.

5. The later-born tend to have a greater incidence of antepartum complications but a lesser incidence of labor complications, although the differences are not statistically reliable.

6. The later-born tend to have a greater percentage of spontaneous deliveries and a greater percentage of normal births. These differences, while favoring the later-born, are not statistically reliable in every comparison.

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